THE PROPOSED COMPREHENSIVE DISTRIBUTION SYSTEM FOR THE LO-MIX ROTATABLE POOL ASSETS

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THESIS

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June 1975

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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ABSTRACT

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TABLE OF CONTENTS

GLOSSARY OF TERMS

AFS

Fleet Replenishment Ship

BASE HISTOGRAM TIME

Time at which initial column of transportation data histograms begin. It is the sum of the mean time for the QUICKTRANS leg plus the flight and ground times for the shortest MAC leg portion.

CASREPT

Casualty Report

CIM

Contract Item Manager. Civilian organization contracted to manage the inventory of selected assets.

CONDITION CODE

A single alphabetic character used to classify an item in terms of readiness for issue and use or to identify action under way to change the status of an item, i.e., in repair, pending modification, conversion, etc. (see NAVSUP Publication 437 for complete list of Condition Codes.)

DEFENSE AUTOMATIC ADDRESSING SYSTEM (DAAS)

A communication network used to route logistic traffic and to provide a variety of logistic services to its subscribers.

DESIGNATED OVERHAUL POINT (DOP)

An activity (including an activity of another service

or a contractor) designated by a Hardware Systems Command or Project Manager to perform the highest (depot) level of repair on a particular item or group of items.

<u>DUE-IN/DUE-OUT FILE (DDF)</u>

The file containing records of assets due-in from suppliers and due-out to customers.

<u>FBM</u>

Fleet Ballistic Missile Submarine

<u>FFG</u>

Guided Missile Frigate - the latest designation of a class of ships in the LO-MIX program. Formerly designated as PF (Patrol Frigate).

<u>IMA</u>

Intermediate Level Maintenance Activity

<u>INVENTORY CONTROL POINT (ICP)</u>

An organizational unit or activity which is assigned primary responsibility for the supply management of a group of items.

<u>INVENTORY MANAGER (IM)</u>

An organizational unit or activity which is assigned the primary responsibility for the supply management of a group of items including responsibility for computing repair requirements.

<u>ISSUE GROUP</u>

Urgency of Need Designator associated with Force/ Activity designator to compute appropriate priority designator category.

ISSUE GROUP I

Priorities 01,02,03,07,08

ISSUE GROUP II

Priorities 04,05,06,09,10

ISSUE GROUP III

Priorities 11 through 15

MAC

Military Aircraft Command, U.S. Air Force

MASTER DATA FILE (MDF)

The file which contains information concerning the characteristics, asset position, requirements, demand and leadtime history, and forecasts (averages) for each item in the system.

MEAN TIME

The mean total time between receipt at a QUICKTRANS origin terminal and the time at the destination when the consignee has been notified that the shipment is ready for pick-up. Included in this time are palletization, manifesting, waiting and loading at origin, the actual transit time, and unloading, inspection, and consignee notification at destination.

MINIMUM TIME

The minimum practical time between receipt at a QUICKTRANS origin terminal and the time at the destination when the consignee has been notified that the shipment is ready for pick-up.

MINIMUM TOTAL TRANSPORT TIME

The theoretical minimum total time required to actually move cargo from origin to destination via the shortest route assuming zero port hold time, handling time, and transshipment time. It is the sum of the flight, ground, and trucking times involved including scheduled stops at intermediate points.

MOVEMENT PRIORITY DESIGNATOR (MPD)

Indicates the priority of movement of the carcass through the transportation system.

MPD 03 -- Critical Item; turn in via most expeditious means including air shipment.

MPD 06 -- HIVAC (High Value Asset Control) or short-supply item; turn in via the most expeditious means including air shipment.

MPD 13 -- Use routine turn-in procedures.

NAVMTO

Navy Material Transportation Office. The Navy's SSCO, among other duties oversees the QUICKTRANS system.

NOT READY FOR ISSUE (NRFI)

Condition code "F" material. Economically repairable material that requires repair or overhaul.

PHM

Guided Missile Patrol Hydrofoil, designation of a class of ships in the LO-MIX program.

PORT HOLD TIME (PHT)

The time elapsed between receipt at a MAC terminal and actual lift aboard the MAC Aircraft.

PSP

Primary Stock Point. Provides primary support to all afloat units and the secondary stock points. Major stock point for Not Ready For Issue carcasses prior to repair.

READY FOR ISSUE (RFI)

Condition code "A" material. New, used, repaired or reconditioned material that is serviceable and issuable to all customers without limitation or restriction.

REPAIRABLE ITEM

An item of durable nature which, when unserviceable, normally can be economically restored to a serviceable condition through regular repair procedures.

ROTATABLE POOL

A selected range of repairable components maintained by a ship, unit, or activity to meet requirements normally supported by the ship, unit, or activity under the remove-replace-repair concept of maintenance. The term "rotatable pool" is synonymous with the term "exchangeable pool."

SPO

Special Projects Office, Washington, D.C. Coordinating activity for all FBM associated projects.

TOTAL TRANSIT TIME

The total of the MAC port hold time, the MAC transit time, and the QUICKTRANS mean time (if a QUICKTRANS segment is involved). This is the time that is

graphed in the histograms of transportation time data.

TRANSACTION ITEM REPORT (TIR)

The Uniform Inventory Control Program (UICP) operation that updates and maintains inventory control records by processing transactions submitted by stock points.

TRANSPORTATION PRIORITY (TP)

A number designating the precedence of movement within the Defense Transportation System. The transportation priority is based upon UMMIPS-assigned issue priorities as follows:

UMMIPS	TP
01-03 "Expedited Handling"	999
01-03	1
04-08	2
09-15	3

UMMIPS

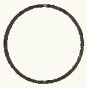
Uniform Material Movement and Issue Priority System

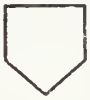
UNIFORM INVENTORY CONTROL PROGRAM (UICP)

The Navy's automated inventory control system. Designed to relieve the Inventory Manager of the bookkeeping and routine decision processing in order that he could concentrate on abnormal situations and decisions having a high dollar or effectiveness impact.

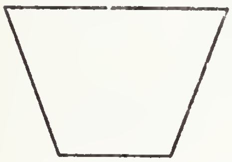
TABLE OF SYMBOLS

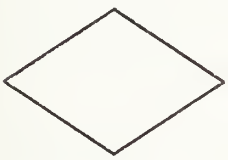
1.  = TERMINAL - The beginning, end, or a point of interruption in a program.

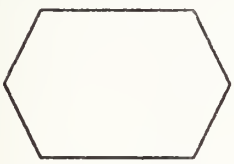
2.  = CONNECTOR - An entry from, or exit to another part of the flowchart.

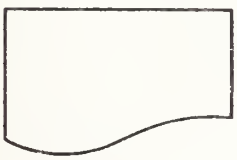
3.  = OFFPAGE CONNECTOR - A connector used to indicate an exit from one page to another.

4.  = PROCESSING INFORMATION - A group of instructions performing a processing function in the program.

5.  = INPUT/OUTPUT - Any function of inputting or outputting information.

6.  = DECISION JUNCTION - Used to indicate a branch based upon variable conditions.

7.  = PREDEFINED PROCESS - A group of operations detailed separately.

8.  = DOCUMENT - Printed output.

LIST OF FIGURES

I. BACKGROUND

A. THE SHIPS (DMS REPORT, 1-7)

The United States Navy will soon add two new classes of ships to the fleet. These are the Guided Missile Patrol Hydrofoil (PHM) and the Guided Missile Frigate (FFG), formerly designated Patrol Frigate (PF).

1. The PHM

In order to maintain a widespread offensive capability without exorbitant investment, the Navy has embarked on a hydrofoil patrol boat construction program. The program is an official NATO project designed to provide a highly effective, small displacement fighting ship for the U.S. and its allies. The Federal Republic of Germany and Italy are involved in the development effort. Germany is expected to have 10 PHM's (five of which are to be constructed in the U.S.) and Italy is to have four to six (one to be constructed in the U.S.). The United States expects to have 24 PHM's by the end of FY-1982.

a. Mission

The mission of the PHM is to operate offensively in local areas and narrow seas against major combatants and other craft. It is also intended to conduct surveillance, screening, and special operations.

During a NATO wartime situation or a limited conflict, PHM's would supplement other naval forces in

blockading strategic straits, searching and engaging in local areas, and close-in protection of other naval forces.

In smaller, localized conflict situations, the PHM would be able to replace higher value forces in surveillance, blockade and interdiction, rapid response to local crises, and search and engagement.

b. Basic Characteristics

Displacement - 224 metric tons

Length - 131 ft.

Draft - 18 ft. foilborne, 5-6 ft. hullborne

Guns - 1 MK75 76mm/62 caliber, rapid-fire, dual-purpose

Missiles - 8 Harpoons

Fire Control System - MK92

Speed - 40+ knots

Endurance - Foilborne: 750 miles at high speed
Hullborne: 5 days at 12 knots
(overload fuel would extend this to 2,000 miles)

Propulsion - Waterjet foilborne operation by single LM 2500 marine gas turbine

Crew - 3 officers; 16 enlisted personnel

c. Major Contractors

Boeing: design services, construction of lead ship plus one follow on

Aerojet-General: waterjet propulsion pumps

General Electric: LM 2500 gas turbines

Litton Industries: Electronic Support Measures (ESM) system

Oto Melara: 76mm caliber gun mount

Other Contractors

David Ehrenpries Consulting Engineers

Electro-Development Corporation

Flight Systems Incorporated

Garrett Airesearch

Hollandse Signaal Apparaten, Netherlands

Anton Kaeser Klimatechnik, Hamburg

Litef Division of Freiburg, W. Germany

McDonnell Douglas Astronautics

Oceanics Incorporated

RSC Industries Incorporated

Scientific Management Associates

Sperry Rand Corporation

Technical Industrial Park

Vitro Laboratories

Wheeler Industries, Incorporated

d. Introduction Schedule (U.S. Ships)

Fiscal Year

75	76	77	78	79	80	81	82	Total
	1		1	6	6	6	4	24

(Note: Commencing with FY-77, the fiscal year will begin 1 October)

e. Employment

The U.S. Navy PHM's are expected to be home-ported in Norfolk (Little Creek) and San Diego.

2. The FFG

The Guided Missile Frigate program is intended to build effective escort ships that are smaller and less costly than the current frigates and destroyers. This smaller-sized class of ships may then be purchased in larger, more adequate numbers. The Navy plans to build 56 FFG's.

a. Mission

The FFG will conduct offensive ASW operations and provide ASW and AAW protection to underway replenishment groups, amphibious forces, and military and merchant shipping. Its AAW capability is provided by the surface-to-air Standard missile and the MK92 fire control system. The 76mm gun will augment the AAW capability. The Harpoon surface-to-surface missile will provide offensive surface combat capability. The FFG's will also carry two LAMPS (Light Airborne Multi-Purpose System) helicopters.

b. Basic Characteristics

Displacement - 3400 tons, full load

Length - 450 ft.

Beam - 45 ft.

Draft, maximum navigation - 23 ft.

Propulsion - single shaft with controllable reversible pitch propeller powered by two LM 2500 marine gas turbines

Shaft HP - 40,000

Speed - 28.5 knots, sustained

Endurance - 4,500 nautical miles at 20 knots

Crew - 14 officers; 162 enlisted personnel

Radar - AN/SPS-49 air search

AN/SPS-55 surface search

Broadcast Receiver - AN/SSR-1 UHF SATCOM

TACAN - AN/SRN-()

Central IFF - AN/UPX-24

Sonar - AN/SQQ-23 PAIR; Tactical Linear Array Sonar System (TACLASS)

Control Panel - MK309

Fire Control System - MK92 Mod 2 dual channel

Missile Launcher - MK13

Missiles - Standard medium range surface-to-air

Harpoon surface-to-surface

Torpedo Launcher - MK32 triple torpedo tubes

Torpedo - MK46

Guns - Close-in-Weapons System (CIWS), 76mm Oto Melara

Helicopters - Two LAMPS

c. Major Contractors

Bath Iron Works Corporation: FFG Ship system construction of lead ship

General Electric: LM 2500 gas turbines

Todd Shipyards Corporation: FFG design support

Other Contractors

Gibbs & Cox, Incorporated

Harbridge House, Incorporated

J. J. Henry Company

Rockwell International

The Singer Company

Sperry Rand

Systems Research Corporation

Vitro Laboratories

Wheeler Industries, Incorporated

d. Introduction Schedule

Fiscal Year									
77	78	79	80	81	82	83	84	85	Total
1			7	9	11	10	11	7	56

(Note: Commencing with FY-77, the fiscal year will begin 1 October.)

e. Employment

Plans currently call for FFG's to be homeported in Norfolk, Charleston, Mayport, San Diego, and Pearl Harbor.

B. THE LO-MIX CONCEPT (PMP, 1-1 THROUGH 2-1) (SIMPSON, 12)

The designs of the PHM and FFG are such that cost, manning, and displacement have been minimized as practicable. With the reduced manpower situation, the shipboard maintenance efforts will be supplemented by Intermediate Maintenance Activities (IMA's) and depot maintenance facilities. These IMA's will generally be in the form of destroyer

tenders (AD's). Depot maintenance facilities are shipyards.

The LO-MIX concept will necessitate new maintenance and logistic strategies. These include:

(1) A major shift of shipboard maintenance to intermediate levels of maintenance (IMA's)

(2) Increased utilization of modular replacement vice on-the-spot repair

(3) Short yard periods between modernizations with increased dependence on equipment change/replacement and IMA responsibility for alterations and field changes...the progressive overhaul concept.

This major shift from shipboard maintenance to intermediate levels will permit manning of the ships with personnel of limited maintenance skills. This allows a concentration of the highly skilled maintenance technicians aboard the tenders and in the other maintenance units. The shipboard personnel will be able to concentrate more time, effort, and training toward the operational aspects of their missions. Corrective action aboard ship will emphasize modular replacement with repair of the module to be accomplished by an IMA or depot maintenance activity.

Appendix A is a comparison of the manning requirements for the DEG-1 class ships and the FFG's (the former designation, PF, is used throughout Appendix A). The

DEG-1 class, currently operational, is similar to the FFG in basic mission and capability.

The DEG-1 complement is 259 people compared to 176 for the FFG. In the high maintenance areas of Deck and Main Propulsion, for example, the FFG manning requirements are significantly lower:

	DEG-1	FFG
Deck	37	17
Main Propulsion	42	14

(See Appendix A for further comparisons.)

The progressive overhaul concept will increase the operating availability of these ships. This concept has the ship and its installed equipment receive overhaul on a progressive basis through more frequent but shorter IMA and depot availabilities. This eliminates the current three to four year regular overhauls of three to nine month duration wherein the ship and its equipment are overhauled at one time and extensive alterations are accomplished. LO-MIX ships will be in a depot for one or two months every two years. Instead of the current ship-to-shop-to-ship basis of equipment overhaul, the modular equipment will be replaced. The removed equipment will be overhauled and/or altered and made ready for issue to another ship. Major modernizations will be planned for approximately every ten years.

This centralized aspect of maintenance should thus enable the Navy to realize savings in overall manpower and in some spare part inventory requirements. While a

somewhat higher range and depth of major components and assemblies will be required to satisfy requirements for scheduled changes during IMA and shipyard availabilities, many repairables and piece-parts formerly carried as on-board spares will only be stocked at IMA's and depot repair facilities.

1. Rotatable Pools

The success of such a program will depend heavily upon the calculation of rotatable pool requirements and their accurate and timely positioning in order to realize the economies envisioned while maintaining a high level of supply support for maintenance operations.

These rotatable pools are stocks of spares of repairable components and assemblies that are established for the replacement of removed units which are undergoing repair, overhaul, or refurbishment. Within the LO-MIX program, two classes of rotatable pools are defined:

A-POOL: Rotating secondary equipment items to support fleet operations between shipyard maintenance occurrences ("unplanned" exchanges)

B-POOL: Major end item pools to satisfy demands during progressive overhauls at shipyards ("planned" exchanges)

2. Program Management

The Chief of Naval Material (CNM) has developed a program management plan (Black Ball 4-72) to respond

to the requirements of these new strategies. A Project Office (PMS-306) has been established in NAVSHIPS to execute this program management plan.

The charter of the project delineates the duties and responsibilities of the Project Manager:

> "The Project Manager is assigned the responsibility to develop, implement, and direct alterations to the current Navy maintenance and supply systems and to modify the management procedures commensurate with these alterations, to assure an adequate, integrated maintenance and supply system to accommodate the new maintenance-limited surface ships." (PMS 306 Charter)

II. STATEMENT OF THE PROBLEM

In order to reap the intended benefits envisioned in the LO-MIX program, a distribution system is required which will facilitate accurate inventory management and forecasting. This system must be capable of being monitored in order to provide current status of repairables within the pipeline. A method of evaluation and priority determination within the system is required. The complexity of the multi-level support network is such that computer processing is necessary. To allow for planning flexibility in system design changes, the computer program itself must be written with a maximum of input routines and a minimum of fixed program procedures. This flexibility is necessary to allow advance evaluation of force, location or inventory support changes. Further, the system simulation must be suitable for use in evaluating inventory policy and procedure costing.

III. HYPOTHESIS

It is possible within the framework and existing directives of the Navy Supply System, with only minor changes which are considered both feasible and economically justifiable, to design a repairable inventory distribution system for the LO-MIX program. This system can provide both the actual physical support for these ships as well as the information necessary to monitor the status and location of repairables within the pipeline. Furthermore, it is possible to model the system in a sufficiently complete and representative format to allow computer simulation for the purpose of inventory policy and program operating doctrine evaluation.

IV. THESIS OBJECTIVES

The overall objective of this thesis is to provide the LO-MIX project with a sound usable system for the distribution of the program's repairable inventory items. Due to the complexity of the total system, it can be viewed as individual parts each of which may be considered an objective within itself. Utilizing this approach, the objectives can be stated as follows:

(1) to provide recommended locations for the repairable inventory stock;

(2) to design a system for the movement of ready-for-issue (RFI) items.

(3) to establish the channels for the movement of not-ready-for-issue (NRFI) items.

(4) to design a monitoring system for RFI and NRFI items to ensure total asset visibility and control at the Inventory Control Point (ICP) level. In addition, the data base developed from this monitoring information will provide input data for future system operating policies;

(5) to model the system in a computer programable and sufficiently accurate manner to permit its use as a decision making tool for present and future system operating policies. This model will initially use projected data which should be replaced by actual program data as the data base from the monitoring system increases. The problems to be addressed by this model include inventory

level determinations, repair policies, facility locations, procurement policies, and shipping and handling policies.

As can be seen from the above elements, the total system is designed to not only provide a means of distributing the items but also incorporates this capability to monitor and control as well as aid in decision making. These features are considered essential elements of a complete distribution system.

V. DISCUSSION

A. DISTRIBUTION SYSTEM

1. Dedicated vs Integrated System

The designs of the PHM/FFG ships are severely constrained in terms of cost, manning and displacement. The LO-MIX concept is based on the ability of the shore established forces to logistically support and maintain this new maintenance criteria.

One primary area of concern can be identified entirely within the area of HI-Value, Repairable asset management directly related to the ability of the supply and maintenance facilities to reduce operational supply deficiencies and maintain fleet operational readiness. In the past few years the growth in modular design of modern weapon systems, based on the cost savings associated with decreased manning requirements for maintenance, has resulted in an increased requirement for repair of system assets at the depot level. In this regard, the LO-MIX concept is dependent upon the maintenance, distribution and management policies afforded this repairable material.

To achieve the LO-MIX goals, a totally dedicated supply system somewhat similar to that presently being utilized in the Fleet Ballistic Missile Submarine (FBM) program might well be thought necessary. A totally dedicated supply system is extremely costly. Further, it involves the totally committed efforts of many military

supply oriented personnel and civilian Contract Item Managers (CIM) in conjunction with a sophisticated computerized reporting and monitoring system.

The FBM system utilizes the Naval Supply Center, Charleston, South Carolina as a primary management and stock point. Although stocking assets common to other weapon system programs, NSC Charleston is the major stock point for FBM assets and most of the management philosophies/policies and computerized programs are FBM oriented. Also, the Special Projects Office, Washington, D.C. (SPO) and two monitoring commands at Polaris Missile Office, Atlantic and Pacific (PMOLANT/PMOPAC) are entirely dedicated to the FBM program.

Specialized personnel and programs are used to monitor and control the FBM repairable assets. For example, McLaughlin Research Corporation is under contract to the Special Projects Office, Washington, D.C. (SPO) to monitor the numerous assets available at various locations in Ready For Issue (RFI)/Not Ready For Issue (NRFI) conditions. This information is available on a daily basis for supply support decisions. The Repair Induction Codes (RIC) are reviewed as required to ensure asset availability and, in many instances, message inductions and changes to the Master Repairables List (MRL) are initiated. Here again, the totally dedicated supply system is quite evident and costly. The FBM Master Repairables List, for example, is produced solely for this program by VITRO, Inc., and

is promulgated/reproduced in accordance with Special Projects Office Instruction 4423.39C. The Naval Supply Center, Charleston, South Carolina, in conjunction with McLaughlin Research Corporation, conducts an annual reconciliation to purify the "A" and "M" condition assets. "A" and "M" condition assets are defined as follows:

"A" condition - New, used, repaired or reconditioned material that is serviceable and issuable to all customers without limitation or restriction.

"M" condition - Material identified on inventory control records but which has been turned over to a maintenance facility or contractor to be repaired.

This type of reconciliation is peculiar to the FBM community, and is not conducted by Inventory Managers for any other Weapon System programs in anything like the same intensity and scope of review.

With the advent of the new Polaris, Poseidon Material Management System (PPMMS) total assets are completely visible from the primary support arena down through the FBM Tender level. This type of dedicated support and detailed asset visibility is presently not available to the surface Navy. A totally dedicated system such as this lends itself entirely to the FBM program because the assets being managed are peculiar to that weapon system alone.

The above described supply support system would, of course, be the optimum means of support for all new weapon systems and weapon systems platforms that may be introduced in the future. But the military cannot afford such a dedicated supply effort to support all of its major programs as has been afforded to the FBM program. In the FFG program, eighty five percent of the rotatable pool items are common to existing surface programs and are not peculiar to the PHM/FFG ships. Also, unlike the FBM programs, these items are not unique in their weapon system/platform application. Consequently, duplication of assets, reports and distribution channels would be inherent in a totally dedicated system thus violating the Naval Supply Systems Command (NAVSUP) and the Defense Supply Agency (DSA) attempts to centralize and control common assets. In addition, the location of the PHM/FFG ships are not as centralized as the FBM submarines and the operating schedules differ greatly.

The LO-MIX system provides the opportunity to combine the latest weapon system technology within the constraints of the present supply support system. It must be remembered that the modular replacement concept within the LO-MIX program is dependent upon the assets available from repair facilities other than at the shipboard level. This program must rely entirely on the success of its distribution and rework network. It is all important that this network be designed such that the distribution system efficiently

supports the program, and that rework/repair facilities are developed to enhance the success of the overhauling/reporting/monitoring system such that required assets are always available for complete operational readiness.

2. Designated Overhaul Point (DOP)

All required overhaul actions on Not Ready For Issue (NRFI) carcasses will be performed on the West Coast. (PMS306/NPGS Conference 9 April 75) Therefore the following numerical assumptions regarding carcass overhaul facilities were made based on data from PMS 306:

- 65% of all NRFI will be overhauled at the Rework Facility, Long Beach, California. (CACI Study dtd 30 Aug 75).
- 35% of all NRFI will be overhauled at NAVELEX S.W. Division and other West Coast rework activities.

3. Inventory Control Point (ICP)

The Primary Inventory Control Point for all LO-MIX rotatable pool assets will be the Ships Parts Control Center (SPCC), Mechanicsburg, PA. (NAVSHIPS PMP, 3.1) In the event other ICP's are identified, the system as designed, will be compatible and useable.

4. Distribution Network

The LO-MIX concept is based upon two entirely new maintenance concepts: (1) reduced maintenance manning levels and (2) extended overhaul cycles. This new concept requires:

(a) shift from shipboard maintenance to other maintenance echelons (IMA & DOP)

(b) module and equipment replacement as required between overhauls

(c) progressive overhauls - periodic significant availability periods e.g., 60 days every 2 years with an extended modernization cycle of 10 years.

In view of the above criteria, it is evident that functions (a) and (b) are of the greatest importance since they reflect the unplanned maintenance required to meet the challenge of the present day tempo of operations. The logistic support system/network must be so designed to satisfy these urgent requirements. The third concept, function (c), is also important, but depends on planned assets prepositioned to meet predetermined overhaul and modernization cycles. The distribution system utilized in this program must be capable of providing responsive supply support for these costly/repairable items as requisitioned within the present Uniform Materiel Movement and Issue Priority System. (OPNAV Inst 4614.1D)

To achieve this goal, the following optimum distribution network has been developed from information provided by the PHM/FFG Project Office (PMS-306) as to PHM, FFG, IMA, SRF, and DOP predetermined locations.

a. Primary Stock Point (PSP)

(1) Location. Many factors affect the location of the Primary Stock Points (PSP) for primary support of

the LO-MIX ships. After analysis NSC San Diego (PSP-West) and NSC Norfolk (PSP-East) were selected. This decision was based on the following evaluation criteria:

(a) better accessability to all forms of transportation modes (government and commercial) as well as transcontinental and overseas network entry.

(b) mechanized transaction item reporting system to ICP/IM.

(c) availability of personnel/equipment/ storage space with minimum investment.

(d) close proximity of Designated Overhaul Points (PSP-West only).

(e) available overseas communication network.

(2) <u>Responsibilities</u>. The Primary Stock Points would be responsible for:

(a) receiving and storing the bulk of the RFI assets. These assets would be available for distribution to the IMA's, FMAG's, SRF's and NSY's as required to support fleet operations between shipyard progressive maintenance occurrences (A-POOL items), resupply of secondary stock points, and to satisfy demands for planned usage during Progressive overhauls at shipyards (B-POOL items). All requirements for B-POOL items should be supplied by the PSP's.

(b) packaging, shipping and monitoring of all overseas and domestic shipments for RFI material.

(c) receiving, stocking and transshipping NRFI carcasses to the appropriate DOP for overhaul. It is assumed that repair inductions will be made on the following basis:

individual inductions----items that are transshipped directly to the DOP for overhaul and not stocked at the PSP in a NRFI condition due to the criticality of system stock.

batch inductions----items that are shipped to the PSP's to be stored in a NRFI condition until quantity shipment to the DOP is authorized by the Inventory Manager.

(d) issuance of transaction item reports to the appropriate ICP/IM for inventory management control on all assets received and shipped, both RFI and NRFI. Transaction Item Reporting (TIR) is the Uniform Inventory Control Program (UICP) operation that updates and maintains Inventory Control Records by processing transactions submitted by stock points or ICP's.

Although not considered a primary stock point, NSC Oakland will also assume the responsibilities delineated in paragraphs (b), (c) and (d) above. This concept will be discussed later in this section.

b. Secondary Stock Point

Secondary stock points will be required to provide primary support for all Issue Group I and II

requisitions. Minimum levels of RFI assets should be prepositioned at NSC Oakland, NSC Charleston, NSC Mayport, NSC Pearl Harbor and NSD Subic Bay. Consequently, primary support will be available in all PHM/FFG homeports as well as the major overseas bases. This NSD/NSC stock will only be used to fill Issue Group I and II requisitions. (Black Ball 4-72, Section III).

SRF/NSY's will only stock RFI assets to meet planned overhaul requirements and should not be considered as secondary stock points. Due to the limited storage space available and primary maintenance responsibilities, the IMA's will not be utilized as secondary stock points.

Figure (1) represents the primary and secondary stock point locations as discussed above.

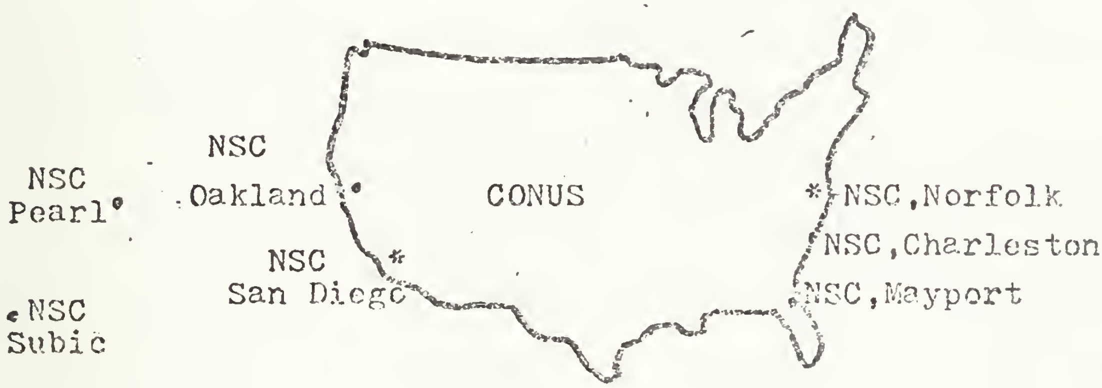
c. Channel of Distribution

The distribution network to be utilized in conjunction with the primary and secondary stock point concept is of critical importance in sustaining the LO-MIX concept. The overall system has been subdivided to depict the exact flow of materials associated with each type of distribution situation.

(1) Ready For Issue Into System Stock. Ready For Issue (RFI) assets are normally obtained via the following methods: (a) Initial Provisioning (b) Repair and (c) Follow-on Procurements.

Although RFI assets may be introduced into the supply system by these three methods, the first point

PRIMARY/SECONDARY STOCK POINT LOCATIONS



* Primary Stock Point (PSP)

• Secondary Stock Point

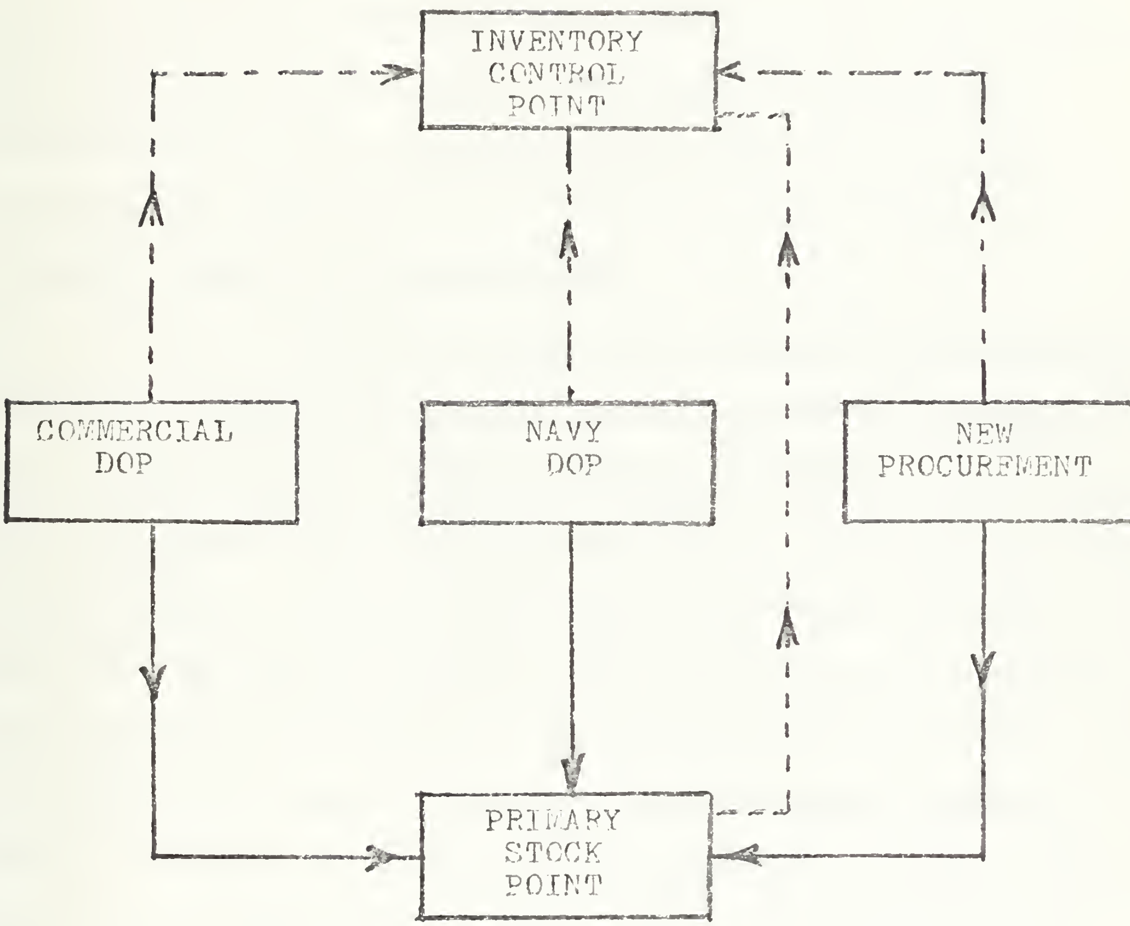
FIGURE 1

of receipt of RFI material is the Primary Stock Point (PSP). The PSP should always be the initial receiving and storage point unless, because of urgency, an asset is diverted to another location by the ICP/IM. This is a significant point, since the PSP is capable of transaction item reporting the receipt of all RFI (A-condition) material thus enabling the ICP/IM to have total RFI condition asset visibility. Consequently, all new assets are totally visible to the ICP/IM at two distinct primary stock points as represented in figure (2).

Restocking of the secondary stock points will be accomplished under the "PUSH" item concept. Under this concept no action is required by the secondary stock points as the ICP/IM monitors all receipts/issues and takes the necessary actions to maintain predetermined inventory levels. Inventory managers will continue to review the repairable asset inventories at the various secondary stock points and authorize direct shipment (Push) from available sources, usually the PSP's,as required.

(2) Requisitions For "Ready For Issue" Material. As in any other logistic support system, the LO-MIX distribution network must be capable of responding to urgent, Issue Group I and II, requirements as well as normal re-stockage objectives to fill allowances and meet scheduled overhaul cycles. Consequently, two complete distribution systems must be available to respond to both the planned and immediate requirements.

READY FOR ISSUE ASSETS INTO SYSTEM STOCK



RFI MATERIAL FLOW
MATERIAL RECEIPT DATA
MATERIAL SHIPMENT DATA

FIGURE 2

The primary/secondary stock point concept provides support to all PHM/FFG's while in home-port. Therefore, ships in home-ports will submit Issue Group I and II requisitions to the applicable primary/secondary stock point for issue. If the required part is not available from this source, the stock point will pass the requisition to the ICP/IM who will either satisfy the requirement from assets available at other sources or expedite repair, as appropriate.

Deployed ships will utilize the new Defense Automatic Addressing System (DAAS) procedures as outlined in the Naval Supply Systems Command (NAVSUP) Instruction 4440.152B and NAVSUP Publication 485 for all priority 01-08 requisitions. The Defense Automatic Addressing System receives electronic messages from authorized subscribers, processes them by keying on the Routing Identifier and transmits the logistic transaction through the Automatic Digital Network (AUTODIN) to the appropriate supply point. Appropriate DAAS supply points should be located at NSC Norfolk on the East Coast and NSC Oakland on the West Coast. These two supply centers performed a similar function prior to the implementation of DAAS and have the required resources available as well as access to Military Airlift Command (MAC) overseas transportation terminals located at Norfolk, Virginia and Travis AFB. Requisitions that cannot be filled at NSC Norfolk/NSC Oakland as appropriate, will be passed to the ICP/IM for supply action.

All Issue Group III requisitions will be submitted directly to the East/West Coast Primary Stock Point as applicable. These requisitions are usually submitted by mail but the DAAS system can be utilized in remote locations. Issue Group III requisitions will be filled from existing stocks at the PSP's, as available, or backordered against future assets undergoing repair.

(3) Not Ready For Issue Carcass Turn-In. The most important source of information regarding repairable asset turn-in is the Master Repairable Item List (MRIL). The MRIL is used by the operating forces and shore activities to simplify identification and expedite movement of items to be repaired for reissue. Published by the Fleet Material Support Office (FMSO) on a bimonthly basis, the MRIL, NAVSUP Publication 4107-N, provides information to the ship that must be utilized if the carcass is to make the repair cycle circuit successfully.

There are three basic sections in each edition of the MRIL:

Part I--Listing of Items: This section contains National Stock Numbers (NSN) and National Item Identification Numbers (NIIN) or Activity Control Numbers (ACN) of repairable items, along with the information required to make turn-in determinations. Items in this section are listed in NIIN or ACN sequence. This section supplies the information associated with the turn-in of carcasses. It tells the end user if a turn-in is required,

where to turn the carcass in and what Movement Priority Designator (MPD) to assign for shipping purposes.

Part II--Part Number-Cross Reference Listing: This section provides the user the means to identify the carcass to a proper National Item Identification Number (NIIN) or Activity Control Number (ACN) utilizing the manufacturer's part number and Federal Supply Code.

Part III--Shipping Information: The last section provides all applicable shipping information including shipping codes, addresses, special instructions and Unit Identification Codes/Federal Supply Codes for Manufacturers (FSCM) to ensure that the carcass is shipped to the proper overhaul point or holding activity.

Eighty-five percent of PHM/FFG program rotatable pool items are common to existing programs, therefore, the authors do not consider it necessary that a special MRIL be published for the PHM/FFG program. Rather, the Special Material Identification Code (SMIC) and Notes section of Part I to the MRIL should be utilized to identify and specify any special handling requirements associated with this program. Consequently, shipping codes, movement priority designators and special information can be readily identified for PHM/FFG type ships. An example utilizing this concept in conjunction with the monitoring system is contained in part D of this section.

Utilizing the MRIL, the carcass is delivered to the nearest turn-in activity (IMA, NSC, NSY, etc.) for further transfer to the holding activity. The location of the holding activity identified in the MRIL is dependent upon the repair facility and Movement Priority Designator (MPD) assigned by the ICP/IM. In consonance with present Naval Supply Systems Command policy, all LO-MIX Not Ready For Issue (NRFI) carcasses will be turned in as follows:

Overhaul/Rework Facility	MPD	Holding Activity
NSY, Long Beach	03/06	NSC Long Beach Annex
NAVELEX S.W. Division	03/06	NSC, San Diego
NSY Long Beach	13	NSC, Norfolk (East Coast) NSC, Oakland (West Coast)
NAVELEX S.W. Division	13	NSC, Norfolk (East Coast) NSC, Oakland (West Coast)

Deployed units will follow the same procedures as specified above but may also utilize the deployed AFS as a transshipment activity.

B. TRANSPORTATION

1. General

The transportation system to be utilized in conjunction with the distribution network must be a coordinated system which will permit the expeditious processing of critical items while at the same time support the routine supply/non-critical items. The distribution network has been designed such that all Primary and Secondary stock

points (except overseas) have access to both premium and over-the-road transportation services.

2. Ready For Issue

The method of transportation employed for the shipment of Ready For Issue material to fill requisitions will depend on the Priority Designator and the Required Delivery Date cited on the requisition. The determination of the method or mode of transportation is the responsibility of the shipping officer and transportation control officers at the various stock points. They will normally employ the most economical mode consistent with the urgency to meet the Uniform Materiel Movement and Issue Priority System (UMMIPS) time frames; high speed transportation to be utilized for material in Priority Designator range 01 through 08. (OPNAV Inst. 4614.1D) Ocean transport may be utilized, if desired, to resupply overseas stock points when it is determined that the on-hand quantity is sufficient to satisfy estimated future requirements until the new stock arrives.

3. Not Ready For Issue

Not Ready For Issue retrograde shipments will be based on the Movement Priority Designator (MPD) assigned by the Inventory Control Point (ICP) as promulgated via the Master Repairables Item List (MRIL). The ICP, based on the asset position of the particular item, will assign MPD 03 and 06 for the movement of items that are considered critical and for which expedited return is essential to

meet repair induction schedules. MPD 13 will be used to ship NRFI carcasses to the holding activity at NSC, Oakland and NSC, Norfolk. MPD 03 and 06 will be afforded premium transportation while MPD 13 will utilize the lower cost over-the-road mode.

4. Military Transportation Resources

In almost all cases, transportation support for the LO-MIX program should be supplied by the three DOD Single Managers of Transportation; Military Airlift Command (MAC), Military Sealift Command (MSC), and Military Traffic Management Command (MTMC) plus the Navy QUICKTRANS assets.

a. MAC provides common-user airlift service for all components of DOD between points in the United States and overseas areas. Also, MAC is the contracting agency for the airlift segment of QUICKTRANS (the Navy's contract cargo airlift/truck service). QUICKTRANS provides service for Navy cargo moving between points of manufacture, overhaul and consumption within CONUS, and delivery of other air eligible cargo between points of generation and MAC aerial ports of embarkation (APOE) for movement overseas. (NAVSUP Publication 441, 19-14 and 19-19)

b. MSC provides ocean transportation for DOD as well as other defense related services. (NAVSUP Publication 441, 19-13)

c. MTMC provides traffic management for the movement of all CONUS military freight tonnage and arranges for the truck service over QUICKTRANS motor routes in addition

to a myriad of other DOD traffic management services. (NAVSUP Publication 441, 19-2, 19-4, 19-9 and 19-10)

It is the belief of the authors that these established military systems should be utilized to the maximum extent since they offer the best coordinated system for the movement of the LO-MIX repairable items. The system appears to be more than adequate for the purpose of repairables movement and deviations are generally costly and hard to justify.

5. Transportation System Alternatives/Improvements

The coordinated system for the shipment of Not Ready For Issue repairables uses premium transportation to the greatest extent except for MPD 13. It is considered more feasible and more economical in the long run to use premium transportation, MAC for out-of-CONUS movement and QUICKTRANS for movement within CONUS, to ship all NRFI retrograde material.

The primary rationale for this decision lies in the relatively high new procurement costs of the repairable items in the rotatable pool. The transportation/inventory tradeoff is a critical point when deciding on management policies associated with these high value items. Prior research indicates that premium transportation costs are often more than offset by the ability to maintain lower inventories of high cost items. (United Research Inc., 5-8) The repairables simulation model and the transportation data presented in a later section is particularly

well suited to explore these considerations and should be utilized in the decision analysis problem.

Shorter in-transit times can also reduce overall repair turn-around-times thereby negating the requirement to maintain huge dollar inventory investments. In this regard, even small improvements in the management of the system could impart substantial savings. (Hamilton, 1971, 5)

Other transportation improvements are also possible. For example, in the area of handling, Port Hold Times (PHT) can be reduced (the Port Hold Time is the time that a part waits at the terminal from the delivery by consignor to loading aboard the vehicle for carriage to its destination). Also, additional flight or feeder truck routes can be added to existing scheduled routes.

The personnel responsible for the LO-MIX Transportation Monitoring/Expediting System will be the strategic element in bringing about this type of improvement. Once they have viewed the actual operation, they will be able to detect inefficiencies and recommend worthwhile and valuable improvements. They will be in a position to observe shipment/transshipment backlogs at the various activities and make recommendations to NAVSUP.

C. REPAIRABLE ASSET MANAGEMENT PROGRAM

1. General

In the past several years, highly sophisticated and very expensive weapon system/platforms have entered

the military inventory. One of the central challenges in this new environment is that of managing the many high-cost repairable components and assemblies on which these new weapon systems rely. Many of these repairable items are so costly and complex that new management strategies must be formulated to ensure optimum utilization of all assets in an environment of limited resources and funding constraints.

In recognition of this need for improved and more intensive management of repairable items within all echelons of the Navy, the Naval Supply Systems Command is developing the IRAM (Improved Repairable Asset Management) Program. Various elements of the new program will be phased-in during Fiscal Year 1975 through 1979 with full implementation by FY 1980.

The IRAM program will consist of three major elements: (Proposed NAVSUP Inst. 4440 dtd 13 Mar 75)

(a) Closed Loop Aeronautical Program (CLAMP)----applicable to a small but significant fraction of aviation-related repairables used on first-line aircraft and support systems.

(b) Fleet Intensified Repairables Management (FIRM)----applicable to a wide range of shipboard weapon systems and to selected repairables within them.

(c) The Repairables Program System Improvements----applicable to all depot-level repairable items. Projected improvements are: (1) improved repairables management

program at mechanized aviation retail activities (2) serial number management (3) better visibility and control of commercially repaired items (4) revised asset and status reporting system (5) mechanized master repairable item list at large automated activities (6) improved repair requirements determination model (7) improved procurement requirements determination model (8) improvements to stock point repair support programs (9) mechanized repair scheduling at organic repair facilities (10) development of repair cycle time goals for better management of the depot-level repair process (11) repairable assistance groups (12) more efficient repairables management system (13) provide written procedures for non-automated activities.

(Note: The FBM Mechanized Repairables Management Program presently in operation at NSC Charleston is also included in the overall IRAM program. The particulars of IRAM and FIRM have not been promulgated to date, however, it is assumed that the FBM repairables program will be included as a subset of element b (FIRM).)

It is anticipated that numerous benefits will be derived from the IRAM program upon full implementation. Although not all inclusive, benefits will result from the following four types of action:

a. Increase of repairable item return rates. This action has three effects: (1) reduces the requirement for procurement of new material; (2) increases the requirement for depot repair of returned carcasses; (3) changes inventory levels, safety levels and leadtime requirements.

b. Reduction of allowance asset levels by using new allowance computation techniques will lead to a one-time reduction in customer levels and new unit procurements.

c. Reduction in turn-around time (TAT) which results in one-time savings in the repair pipeline stocks and safety stock.

d. Reduction of time to ship replacement Ready For Issue (RFI) from warehouse to customer, resulting in reduced order and shipping times.

As mentioned in Section I, the LO-MIX ships, PHM/FFG, will utilize modular replacement for corrective maintenance at the shipboard level with repair of failed units at the depot level. This replace/repair technique is an important part of the overall LO-MIX concept and intensive management techniques will be required for all rotatable pool items.

2. LO-MIX Repairable Asset Management (LO-RAM)

As stated above, the Naval Supply Systems Command (NAVSUP) has recognized the need for a more intensified repairable management program and has directed the development and implementation of the Improved Repairable Asset Management (IRAM) program. Due to the importance of the rotatable pool items to the LO-MIX program and their HiValue/Repairable nature, these assets qualify for intensive management and therefore should be included in the new IRAM program.

The decision to be made is, "where to include the LO-MIX items within the IRAM program?" As stated in paragraph 1 of this section, the IRAM program will consist of three major elements: (1) CLAMP (2) FIRM and (3) System Improvements. The CLAMP portion is presently applicable to a small number of high value aviation repairable components with plans for expansion in the FY75-76 time frame due to its success. The CLAMP program is directly associated with aviation material managed by the Aviation Supply Office (ASO) utilizing Naval Air Rework Facilities as rework/overhaul activities. On the other hand, the second element, FIRM, is directly applicable to shipboard components managed by the Ships Parts Control Center (SPCC) and repaired primarily (some civilian overhaul facilities are utilized) at two distinct overhaul facilities; NSY Long Beach (Ordnance, Hull, Mechanical & Electrical) and NAVELEX S.W. Division (Electronic). The asset management techniques applicable to the shipboard repairable components are presently under review by NAVSUP, and it is envisioned that new intensive asset management techniques will be forthcoming.

Element number three, Repairables Program System Improvements, is designed to introduce new and innovative management techniques to the entire repairable management arena. Many of the projected improvement areas as stated in paragraph 1(c) of this section have already been assigned to action codes within NAVSUP, ASO, SPCC, FMSO and related stock points for investigation and recommendations.

In some instances, specific action has already been initiated; for example, the projected improvement, "provide repairable assistance groups at key turn-in points" (item c(11)) has been implemented. To date, Fleet Repairables Assistance Agents (FRAA) have been placed at NSC San Diego, NSC Oakland, NSC Pearl Harbor, NSD Subic Bay, NSC Norfolk, NSC Charleston, NSC Mayport and in the Mediterranean area. Although specific duties have not yet been totally developed for the FRAA's, (recommendations to follow in Section D), their main objective is to work with local stock points and fleet units to assist in coordinating the expeditious and proper return of Not Ready For Issue Repairables. Another improvement, the Inventory Control Point (ICP) Repairables Management Monitoring System (Program B05) is in the final development stage at FMSO which will enable the ICP to (1) monitor repairable item turn-ins, (2) follow-up on overdue or missing carcasses, (3) generate carcass return and retrograde data, and (4) measure ship and activity performance relative to established repairables management procedures.

The decision to be made is not an easy one. To complicate matters, presently, a complete list of National Item Identification Numbers (NIIN) for all rotatable pool items applicable to the PHM/FFG program is not available. Further, it can not be determined at this time what percentage of the total assets of each common item (items not peculiar to the LO-MIX ships but also used in other programs)

will be required to support the LO-MIX ships. (PMS 306/NPGS Conference 9 Apr 75) This data would be used to identify specific items that qualify for management under element b (FIRM) of the IRAM program.

Because of the important role of repairable components in the LO-MIX concept, the uncertainties described above, and the commonality of ICP, shipboard equipments and repair/overhaul activities, all LO-MIX rotatable pool assets should be managed as a sub-set of FIRM and be referred to as LO-RAMS (LO-MIX Repairable Asset Management System). Utilizing this sub-system concept, the LO-RAMS will benefit from any intensified management techniques implemented under the FIRM concept and at the same time, reap the rewards of any new and innovative system improvements realized from the third element, repairables program system improvements, of IRAM.

Additional resources should be made available to SPCC to manage the entire range of LO-MIX items, although the majority of items initially will be common to existing programs, under LO-RAMS. When more information is available and uncertainties resolved, an alternate solution may be to manage within FIRM those items meeting selection criteria and to manage the residual items under LO-RAMS. This transition should not be difficult since only one Inventory Control Point is involved. Item managers will be familiar with in-house procedures and reporting channels will remain constant.

D. MANAGEMENT INFORMATION SYSTEM

1. General

The success of any new program is primarily dependent upon timely feedback to managerial personnel to evaluate the performance of the system and to capture valuable information for audit trails and as a basis for future decisions. This basic managerial philosophy is especially critical in the repairables management area.

Weapon systems on ships and aircraft are constantly increasing in sophistication, with the result that modular replacement is a necessity to maintain operational readiness. This is particularly true for the PHM/FFG ships where the modular replacement or LO-MIX concept will be used extensively. Of primary concern is the fact that repairable material represents an extremely high investment of Navy dollars in proportion to the total value of the Navy's inventory. This large investment is due to the high cost of the individual items, which run into thousands of dollars per line item.

Because individual cost per line item is of major significance, the Navy cannot afford to be extravagant by maintaining high inventory levels to meet anticipated demands. Rather, it is more commonplace to find the inventory level low for many of these high priced items with the inventory manager resorting to repair vice procure decisions. Due to the resulting short supply situation, inventory managers are forced to devote maximum attention

to the issues, carcass availability and repair aspects associated with the repairable assets. In this regard, it follows that a mechanized Management Information System to monitor receipts, repairs, carcass turn-ins and issues is a necessary tool for providing the information required to manage these numerous expensive/critical repairable assets. Only in this manner will total asset visibility become a reality.

The Management Information System in the LO-MIX Repairable Asset Management System (LO-RAMS) must be compatible with all segments of the overall IRAM program. This system must not duplicate the resources/responsibilities of the new repairable management system but should complement the system by providing additional information and personnel to manage the LO-MIX items within the framework of the IRAM regulations. The following system has been designed to accomplish this objective although it realized that some of the concepts/recommendations presented here may be considered too expensive or not feasible at the present time. The ultimate decision is left to the implementation authority.

2. <u>Not Ready For Issue (NRFI) Carcass Monitoring</u>

a. Identification

(1) Master Repairables Item List (MRIL). The Master Repairable Item List (MRIL) will be used to identify LO-MIX repairable items and provide shipping instructions/addresses to complete all turn-in transactions. The notes

section in Part I of the MRIL will be utilized to identify LO-RAMS managed items. This can be accomplished by printing "LO-RAMS" or "PHM/FFG" in the notes section (card columns 45-70). All ships/stations should be notified by Fleet Material Support Office Notice of the forthcoming change to include the LO-MIX repairable items in the MRIL and the Notice should also include a brief explanation of the acronyms. Figure (3) depicts a sample page of the MRIL with notes.

In addition to the above, a Special Material Identification Code (SMIC) can be assigned to the LO-MIX items and included in the MRIL information. This SMIC code is used to identify items with their appropriate weapons system or identify them as special material. Either or both of the above recommendations should be sufficient to identify the LO-MIX items within the MRIL.

A third alternative is to assign special Activity Control Numbers (ACN's) to all of the LO-MIX items for positive identification. However, this alternative is not recommended since it may lead to confusion in the cross referencing of ACN to National Item Identification Number (NIIN) and economies in procurement and quantity repair inductions may be foregone. Also, duplication of resources will be required and inefficiences would result from reviewing the ACN's and FIIN's separately.

(2) Mechanized Master Repairables Item List (Mechanized MRIL). A Mechanized MRIL program should be

Part I of the MRIL

Acount Code/ COG Symbol Material Control Code	National Stock Number/Activity Control Number	Special Material Identifi- cation Code	Repair Level Code	Security Class	Shipping Code	MPD	Notes
C M O C G C	NSN/ACN	SMIC	R L C	S E C	SHPG CODE	M P D	NOTES
2H	9999-00-HDO-1204		D	U	N00181	13	CTNR 22
4G H	6630-00-351-5958	LR	D	U	C30008	03	
2F H	5845-00-355-5334		O	U	N00146	13	LO-RAMS
2H G	4720-00-450-9846	Q1		U	ZZ	06	
1H D	5440-00-451-9847	TE	I	U	WW		LO-RAMS
2H H	1240-00-321-9743		D	U	YY		BLUE STRIPE

FIGURE 3

developed by FMSO to be automated within the Uniform Automated Data Processing System (UADPS) for Stock Points. This Mechanized MRIL will be used to (1) verify shipping information (2) prepare shipping documents and (3) initiate TIR's for the "first point" receipt and shipment of the NRFI carcass (this procedure is discussed later in this section). The program should be maintained on the Master Stock Item Record (MSIR) to provide Proof of Shipment and Proof of Receipt information for future audit trails when shipping documents and TIR's are generated.

b. Turn-In (Responsibilities/Documentation)

The first phase in the monitoring system involves the exchange of the NRFI "F" Condition carcass for an RFI "A" Condition replacement unit. The requisition for a repairable item must contain an Advice Code to advise the Inventory Control Point (ICP) the reason why the item is required and if a turn-in will be generated. If a NRFI carcass is available for turn-in, Advice Code 5G will be annotated in card columns 65 and 66 of the requisition, DD Form 1348. The following Advice Codes are applicable to repairable items: (SPCC Inst. 4440.432, 3-2)

Columns 65	66	
5	A	Replacement certification. Requested item is required to replace a mandatory turn-in repairable which has been surveyed as missing or obviously damaged beyond repair.

Columns 65	66	
5	D	Initial requirement certification. Requested item is a mandatory turn-in repairable required for initial outfitting/installation or increased allowance/stockage objective; therefore, no unserviceable unit is available for turn-in.
5	G	Exchange certification. (1) Requested item is a mandatory turn-in repairable for which an unserviceable unit will be turned in on an exchange basis under the same document number as that used in the requisition; (2) Requested item is compressed gas for which an empty cylinder will be turned in on an exchange basis.
5	X	Stock replenishment certification. Requested item is required for stock replenishment of a mandatory turn-in repairable for which unserviceable units have been or will be turned in for repair.

Upon issue of the "A" condition item, the issuing activity will generate a TIR to the ICP. This TIR contains various pieces of information, but specifically tells the ICP the requisition number and Advice Code of the original requisition. Requisitions received which do not cite one of the valid Advice Codes (automatic review accomplished through the Carcass Tracking File with exception data output) will be challenged and action will be initiated to obtain the correct Advice Code from the

requisitioner. A sample "Naval Speedletter" presently utilized by the Ships Parts Control Center (SPCC) is shown in figure (4). If a valid Advice Code is cited, the ICP will input all applicable information into the Master Data File (MDF) and Carcass Tracking File (CTF). Other files may be affected, but these two are considered most important to the carcass monitoring system. The MDF and CTF are presently in operation at the Ships Parts Control Center (SPCC).

The Master Data File (MDF) is one of the most important files of the Uniform Inventory Control Program (UICP). The MDF is organized by NIIN with data elements describing the item, stock status, etc. associated with each NIIN. Data elements are adjusted by processing the TIR's received at the ICP. Three of the most significant data elements are: (1) On-Hand Quantity (2) Activity Due-In and (3) Activity Due-Out. The MDF lists, in activity/location sequence, the Ready For Issue, Items in Repair and Not Ready For Issue ("A", "M" and "F" Condition Codes respectively) assets available at the various locations. The system total for any condition code can always be determined for any one item by adding the individual totals for each activity. Another available file utilized by the UICP is the Due-In/Due-Out File (DDF). This file records much of the same information as the MDF, but the data is more definitive in nature. For example, applicable document numbers are recorded and the exact

NAVAL SPEEDLETTER FOR "ADVICE CODE" INFORMATION

TO:

Requisition ______________ for qty __________ FSN __________

was received with/without appropriate advice code ______

Maintenance of proper asset audit trail for repairables requires the following information be promptly submitted:

- [ ] Advice code blank - submit appropriate code.
- [ ] 5A - survey document required.
- [ ] 5D -
- [ ] 5G - Forward Form 1348-1 with complete SHIPDA.

ADDRESS:

COMMANDING OFFICER
NAVY SHIPS PARTS CONTROL CENTER
MECHANICSBURG, PA 17055
ATTN: CODE

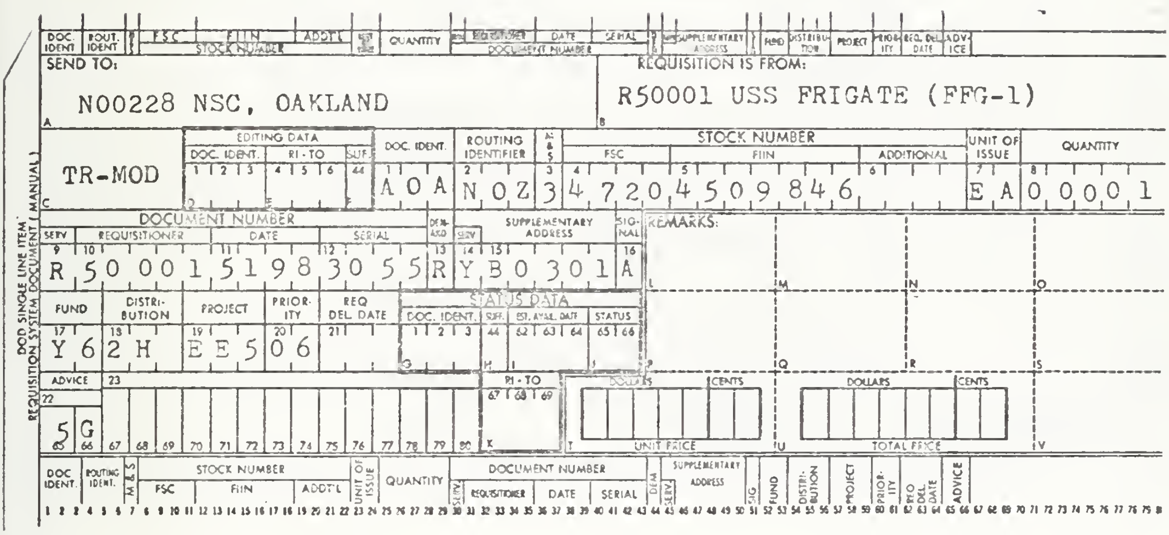
FIGURE 4

reason for the change to on-hand balances. As the information is very similar and simultaneous updating occurs through the TIR system, the MDF will only be referred to in this section.

The Carcass Tracking File (CTF) is a SPCC unique mechanized program for tracking carcasses and basically operates by matching "A" condition issues to "F" condition receipts utilizing requisition and turn-in document numbers. The TIR's are automatically input to the program and weekly action reports generated. The principles/operation of the program will be discussed throughout this section. (Note: The Retrograde Control System of the new B05 UICP Repairables Management Monitoring System presently in the development stage will replace the Carcass Tracking System when implemented, but basically the two programs accomplish the same objectives - refer to paragraph b (1) below).

To achieve this "matching objective," the requisitioning activity will utilize DD Form 1348-1 as the turn-in document for NRFI repairable items. The document number on the DD Form 1348-1 must be exactly the same as the requisition number utilized to order the replacement unit. Sample DD Form 1348 and 1348-1 are shown in figures (5), (6), and (7). Upon receipt of the carcass at a TIR activity (NSC, NSD, etc.) the Stock Point will utilize the Mechanized MRIL program to automatically verify all shipping data, produce a new shipping document if

REPLACEMENT REQUISITIONING DOCUMENT



DOD SINGLE LINE ITEM REQUISITION SYSTEM DOCUMENT (MANUAL)

SEND TO: N00228 NSC, OAKLAND

REQUISITION IS FROM: R50001 USS FRIGATE (FFG-1)

TR-MOD

DOC. IDENT.: A0A

ROUTING IDENTIFIER: N0Z

M & S: 3

STOCK NUMBER: 4720 450 9846

UNIT OF ISSUE: EA

QUANTITY: 00001

DOCUMENT NUMBER: R50001 5198 3055

DEMAND: R

SUPPLEMENTARY ADDRESS: YB0301

SIGNAL: A

FUND: Y6

DISTRIBUTION: 2H

PROJECT: EE5

PRIORITY: 06

ADVICE: 5G

REMARKS:

FIGURE 5

DIRECT TURN-IN TO HOLDING ACTIVITY

PRIORITY 13

DOC IDENT	RI FROM	STOCK OR PART NUMBER	DOCUMENT NUMBER		DISTRIBUTION	PROJECT	PRIORITY		
BC1		47204509846	EA00001R5000151983055		2H		13	F	G

SHIPPED FROM	SHIP TO	MARK FOR	PROJECT	TOTAL PRICE
A R50001 USS FRIGATE (FFG-1)	B N00228 NSC, OAKLAND, CA.	C	O	E

WAREHOUSE LOCATION	TYPE OF CARGO	UNIT PACK	UNIT WEIGHT	UNIT CUBE	U F C	N M F C	FREIGHT RATE		DOCUMENT DATE	MAT COND	QUANTITY		
F	G	H	I	J	K	L	M	N	O	P F	Q	R	S

SUBSTITUTE DATA (ITEM ORIGINALLY REQUESTED)	FREIGHT CLASSIFICATION NOMENCLATURE	
T	U	V JCN 50001-0E01-5024
W	X ITEM NOMENCLATURE TR MODULE	Y

SHIPPERS			RECEIVERS	
1 SELECTED BY AND DATE	2 TYPE OF CONTAINER(S)	3 TOTAL WEIGHT	7 RECEIVED BY AND DATE	8 INSPECTED BY AND DATE
4 PACKED BY AND DATE	5 NO OF CONTAINERS	6 TOTAL CUBE	9 WAREHOUSED BY AND DATE	10 WAREHOUSE LOCATION

REMARKS				
AA	BB	CC	DD LO-RAMS REPAIRABLE	EE
11 FIRST DESTINATION ADDRESS	12 DATE SHIPPED		FF APPROVED FOR SHIPMENT:	GG A.T.SEA,LT,SC,USN By direction
13 TRANSPORTATION CHARGEABLE TO	14. B/LADING, AWB, OR RECEIVER'S SIGNATURE (AND DATE)	15 RECEIVER'S DOCUMENT NUMBER		

DOD SINGLE LINE ITEM RELEASE/RECEIPT DOCUMENT

DD FORM 1348-1 1 AUG 61

S/N 0102 013 1700

FIGURE 6

TRANSSHIPMENT TURN-IN TO OVERHAUL FACILITY

PRIORITY 03/06

BC1 47204509846 EA00001R5000151983055 2H 03 FG

SHIPPED FROM
A R50001
USS FRIGATE (FFG-1)

SHIP TO
B N00638
NSC, LONG BEACH, CA.

MARK FOR C

PROJECT O

TOTAL PRICE DOLLARS CTS E

MAT COND P: F

V: JCN 50001-CE01-5024

ITEM NOMENCLATURE
X: TR MODULE

REMARKS

DD: LO-RAMS REPAIRABLE (REDSTRIPE)

FIRST DESTINATION ADDRESS
11 N00228
NSC, OAKLAND, CA.

DATE SHIPPED
12 5201

FF: APPROVED FOR SHIPMENT:

GG: A.T.SEA,LT,SC,USN
By direction

13 TRANSPORTATION CHARGEABLE TO

14 B/LADING, AWB, OR RECEIVER'S SIGNATURE (AND DATE)

15 RECEIVER'S DOCUMENT NUMBER

DOD SINGLE LINE ITEM RELEASE/RECEIPT DOCUMENT

DD FORM 1348-1 1 AUG 61

S/N 0102 013 1700

FIGURE 7

required and transship the carcass to the appropriate Holding Activity or Designated Overhaul Point (DOP). The Mechanized MRIL should also be designed to automatically produce two TIR's. The first TIR should be immediately transmitted to the ICP. This action will (1) acknowledge receipt of the carcass at the Stock Point (2) adjust the "F" Condition "On-Hand Quantity" on the MDF for that activity and (3) provide a document match within the CTF (this requisition/turn-in document match in the CTF is proof that the requisitioning activity has fulfilled its obligation for the turn-in of the failed carcass). Consequently, the ICP is cognizant of the following information: (1) that a NRFI carcass has entered the supply system (2) the exact location of the NRFI carcass (3) the date received/processed at the TIR activity and (4) the activity presently responsible for the carcass.

The second TIR, which also generated from the Mechanized MRIL, should be complete except for the shipping data. When the item is actually shipped to the holding activity, this information should be included on the TIR and transmitted to the ICP. This TR will establish a "Due-In" date of the "F" Condition asset on the MDF under the "ship-to" Holding Activity and establish the shipping date. This transaction will also reduce the "F" Condition On-Hand Quantity on the MDF for the shipping activity. Consequently, a "first point" audit trail has been established with the capability to monitor activity performance

and accumulate transshipment lead times. Activity performance can be determined by calculating the difference between the date of actual shipment (second TIR) and the date of receipt of the carcass at the Stock Point (first TIR date). This value will provide the number of days it took to process the paperwork and actually place the carcass in the carriers hands.

Upon receipt of the NRFI carcass at destination, the Holding Activity will generate a TIR to the ICP which will update the MDF and relieve the transshipment activity of responsibility. The asset is now in stock at the proper location and is recorded in the "On-Hand Quantity" balance of the holding activity. Transshipment lead time can be determined by calculating the difference between the receipt date of the carcass as reported by the holding activity and the date of shipment from the transshipment activity.

In the present system, the transshipment Stock Point does not TIR the receipt or transshipment of the NRFI carcass to the ICP. The first report on the availability of the carcass to the ICP takes place when a TIR is generated by the final destination activity/holding activity/DOP upon receipt of the carcass. This transaction is then recorded in the "F" Condition "On-Hand Quantity" data element in the MDF for that activity. At the same time, the document match is made in the CTF. Consequently the only audit trail available to the ICP is through the actual turn-in activity, which in all probability is an afloat

unit. There is no method to track the NRFI carcass through transshipment points nor is there a system to monitor activity performance or accumulate transshipment data.

In addition, a report of issues and receipts which are not matched in the CTF is generated weekly for management review and follow-up action. Presently, SPCC is initiating first follow-up action on all unmatched documents where the TIR date plus 90 is less than the current Julian date. A second listing of unmatched transaction is received when the TIR date plus 150 is less than the current Julian date. (SPCC Inst. 4440.432, 9-3) A copy of the "Naval Speedletter" used for follow-up action is shown in figure (8).

Under the proposed dual TIR system, transshipment time frames between specific points can be calculated. With this data and the Military Airlift Command (MAC)/ Quicktrans information provided in Section VI, realistic transshipment times can be determined. This data can then be used to determine meaningful "shipper to destination" time frames for follow-up action rather than the arbitrary system of 90 and 150 days now being utilized. For example, if the mean time to transship a carcass from NSC Charleston, S.C. to NSC Norfolk, Va. is three days, then follow-up action on an unmatched document between these two points should be initiated no later than the TIR date plus 7 days (Note: 7 days should be the optimum time frame for follow-up due to delays in the delivery of CTF unmatched document

OPNAV 5216/145 (Rev. 3-71)
(SPCC OVPT A) (4-74) (LOCAL)

USE FOR URGENT LETTERS, ONLY

Naval Speedletter

DO NOT CLEAR THROUGH COMMUNICATIONS OFFICE

CHECK TYPE OF MAIL	CLASSIFICATION		INSTRUCTIONS
☐ REGULAR ☐ REGISTERED ☐ AIR ☐ CERTIFIED ☐ SPECIAL DELIVERY	DATE	IN REPLY REFER TO	

To:

INSTRUCTIONS

1. Message type phraseology is permissible.

2. Both addresses must be appropriate for window envelope or bulk mailing, as intended. Include attention codes, when known. Use dots and brackets as guides for window envelope addresses.

3. Give priority to processing, routing, and action required. Avoid time-consuming controls.

4. In order to speed processing, a readily identifiable, special window envelope, OPNAV 5216/145A, Speedletter Envelope, is provided for unclassified speedletters where bulk mailing is not used. Other window envelopes also may be used. In bulk mail, speedletters should be placed on top of regular correspondence.

Fold

STANDARD REFERENCES AND ENCLOSURES IF ANY: TEXT AND SIGNATURE BLOCK

Ref: (a) NAVSUP PUB 4107N (Master Repairable Item List)
(b) NAVSUP PUB P-485 (Afloat Supply Procedures) Para 5090-5094

Requisition	For Qty	Nomenclature	FSN

has been supplied. However, to date, receipt of the inoperative unit has not been reported by the designated receiving activity listed in reference (a). If the ultimate consignee was other than a Naval Supply Center or Naval Shipyard, SPCC failed to receive a copy of the DD Form 1348-1 turn-in document as prescribed in paragraph 5092.2 of reference (b).

It is essential that the customer assure timely turn-in of inoperative material to sustain system support capability. This requires an asset audit trail for repairable turn-ins utilizing the same document number as that used to requisition the replacement unit, and the use of suffic code "T" in card column 44 of the turn-in document (DD Form 1348-1).

The following action is required:

1. If the failed unit has not yet been turned in, expedite turn-in in accordance with references (a) and (b).

2. If the failed unit has been turned in, provide the following information:

   a. Activity to which failed unit was shipped/delivered ______
   b. Method of shipment/delivery ______
   c. Turn-in document number ______
   d. Date turned in ______

Fold

3. If unit was removed by shipyard or tender during availability, endorse to that activity for action with info copy to SPCC.

By direction

COPY TO

From:

COMMANDING OFFICER
NAVY SHIPS PARTS CONTROL CENTER
MECHANICSBURG, PENNA. 17055
ATTN: CODE

← ADDRESS REPLY AS SHOWN AT LEFT; OR, REPLY HEREON AND RETURN

FIGURE 8

reports and to avoid excessive resource utilization). This transshipment data can also be used in the "Repairables Simulation" model as developed in Section VI.

In summation, this proposed dual TIR tracking system will provide the following benefits when initiated:

a. improved asset visibility during the transshipment period

b. mechanized verification and preparation of shipping documents

c. create stock point "Proof of Receipt/ Proof of Shipment" Master Stock Item Record

d. more refined audit trails for tracking carcasses

e. identify specific carcass accountability

f. reduce carcass tracking time by direct communication with first destination shore addees vice afloat units when initial TIR's are received

g. expeditious follow-up action based on shipping mean times

h. realistic transshipment data for the Repairables Simulation model

i. capability to monitor the performance of transshipping activities.

A representation of the entire NRFI carcass monitoring system is shown in figure (9).

(1) <u>The Retrograde Control System (RCS)</u>. The Fleet Material Support Office (FMSO) is presently developing the Retrograde Control System (RCS) to replace the Carcass

NOT READY FOR ISSUE CARCASS MONITORING SYSTEM

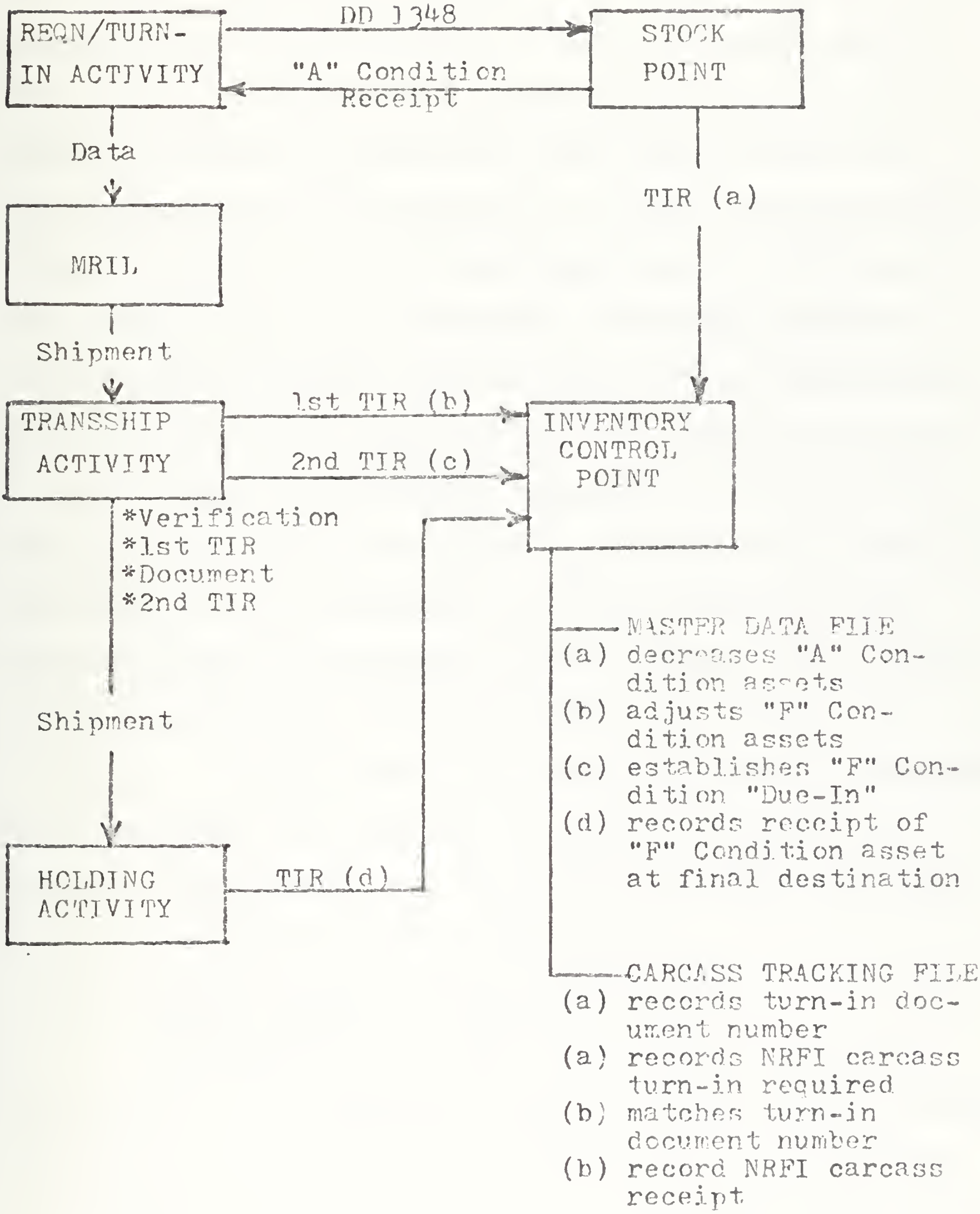


FIGURE 9

Tracking File (CTF) at SPCC. This new system will be very much like the present system but, more definitive in nature. The RCS will still utilize the matching concept to match requisition numbers to turn-in document numbers. In addition to producing an unmatched document listing for follow-up action (revised to 45 days from 90 days) this program will have the capability to monitor the performance of all activities in the repairables cycle. The program will essentially count the number of mistakes generated in the requisitioning, reporting and turn-in transactions initiated by various activities in the repairables arena. A fewer number of mistakes corresponds to a high score, while many mistakes contribute significantly to a low score. This part of the program will be used to identify poor performers who are candidate for the application of corrective measures within the repairables program.

The monitoring system discussed in paragraph 2.a. above will be completely compatible with the new Retrograde Control System and provide the additional data to further measure activity performance.

3. Repair Segment of the Repair Cycle

In paragraph 2.b. above, the monitoring system applicable to the Repairable Exchange Process and Retrograde movement was presented. This NRFI carcass turn-in phase is considered the first segment of the actual repair cycle. In this section, the second segment or repair segment of the repair cycle will be discussed. The repair segment involves

the authorization, shipment, reporting and condition code transfer actions required for the carcass to complete the repair cycle from NRFI ("F" Condition) to RFI ("A" Condition) successfully.

To achieve asset visibility during the repair segment, the Condition Code "M" is used to identify material that has been inducted for repair. A more precise definition is: material identified on inventory control records but which has been turned over to a maintenance facility or contractor to be repaired. (NAVSUP Publication 485, A9-10)

In the repair of the LO-MIX items, Navy overhaul points will be used extensively. There may, however, be a possibility that a small percentage of the items will require overhaul at a Commercial activity. Because there are distinct differences in the induction process and reporting techniques associated with each type overhaul activity, each system will be discussed separately.

a. Navy Designated Overhaul Points

The repair induction process begins when a determination is made by the Inventory Manager at the ICP that additional RFI assets of a certain item will be required to meet anticipated usage. At this time, a redistribution order is forwarded to the holding activity to ship a quantity of NRFI carcasses to a Designated Overhaul Point (DOP). This redistribution order should establish an Activity Due-Out record for the holding

activity on the Master Data File (MDF); a record of this transaction will also be made in the Due-Out section of the Due-In/Due-Out File (DDF) but as mentioned earlier, the MDF will only be used to illustrate the applicable transactions.

Upon receipt of the redistribution order, the holding activity will ship the required NRFI carcasses to the appropriate DOP. At this time, a TIR is forwarded to the ICP. This TIR will clear the previous Activity Due-Out record on the MDF established by the redistribution order and establish an Activity Due-In for the DOP. Here again, an audit trail has been established to monitor activity performance by determining the number of days it takes for various activities to process the redistribution order and ship the NRFI carcasses. This processing time can be computed by calculating the difference between the time the holding activity TIR's the actual shipment and the original date of the redistribution order. Also, this system will enable inventory managers to initiate follow-up action if shipments are not accomplished within predetermined time frames. For example, suppose the predetermined processing time frame for shipment of 1-15 NRFI carcasses by a holding activity is established to be 10 days. The DDF file can be scanned biweekly to determine the various activities that are holding redistribution orders in excess of 10 days for which shipment TIR's have not been received. Follow-up action will then be initiated to expedite shipment.

Receipt of shipment at the DOP will be acknowledged by a TIR. This TIR will clear the previous Activity Due-In record established for the DOP and update the On-Hand Quantity "F" condition record. This transaction will inform the inventory manager that the carcasses have been received and are ready for repair.

Once again, an audit trail has been established. The inventory manager is capable of accumulating shipping time frames between the holding activity and the DOP by calculating the difference between the date of receipt at the DOP and the date of shipment from the holding activity. Mean shipping times between various points can be determined and utilized in the Repairable Simulation model. Also, if after shipment, the receipt TIR is not received within a predetermined time frame (based on shipping times previously experienced) follow-up action can be initiated. Many of these follow-up actions can be accomplished by computer file scan and exception output programs vice manual techniques.

After receipt of the carcasses at the DOP the inventory manager will provide the funds required and authorize repair (this transaction may also take place prior to the actual receipt of the carcasses at the DOP). When the DOP actually inducts the carcasses into repair, it provides a TIR to reflect the transaction of the NRFI material into Condition Code "M". This transaction will decrease the On-Hand "F" condition quantity and increase the On-Hand "M" condition quantity on the MDF record.

b. Commercial Designated Overhaul Point

The Commercial Designated Overhaul Points do not possess the Transaction Item Reporting capabilities presently utilized by the Navy. Consequently it takes longer to accumulate the required data for management/ monitoring purposes.

The requirements determination is accomplished in the same manner as for a Navy DOP, but instead of the redistribution order, a referral order is forwarded to the holding activity to authorize shipment of the NRFI carcasses to the Commercial DOP.

Upon shipment by the holding activity, a TIR will be generated to decrease the On-Hand Quantity for that activity on the MDF. This TIR will also update the Repair Contract File (RCF) to show that material was shipped to the Commercial DOP. The Repair Contract File lists all the current commercial repair contracts and is designed to gain visibility and account for assets undergoing repair at Commercial DOP's. Simultaneously, the Due-In/Due-Out File (DDF) will be updated to show the material undergoing repair at the Commercial Activity.

When the referral order is sent to the holding activity, a repair authorization package should be forwarded to the Commercial DOP. This package should include all of the documents required (contract number, funding, distribution of assets when repaired, etc.) for overhaul to commence plus three Prepositioned Material Receipt Cards

(PMRC). These three PMRC's will correspond to the TIR's submitted by Navy DOP's in the repair cycle and will be mailed by the Commercial DOP to the ICP when each prescribed action has been completed. The Prepositioned Material Receipt Cards will accomplish the following objectives.

Card No. 1 --- Acknowledge receipt of the NRFI carcasses at the overhaul point.

Card No. 2 --- Report the Condition Code transfer from "F" to "M" condition when the material is actually inducted into repair.

Card No. 3 --- Report shipment of the RFI "A" condition item when repair has been completed and the item is actually shipped.

Cards 1 and 2 will be used to update the RCF file and provide current information regarding the receipt and repair of the carcass. Card number 3 will be used to clear the RCF file and establish an Activity Due-In record on the MDF under the consignee activity.

Utilizing this 3 card system, the computer files will contain up-to-date information required to (1) make intelligent management decisions (2) monitor carcass status and (3) accumulate shipping/repair time frames. Activity performance and follow-up actions can be accomplished by the methods described in paragraph 3 a. above.

4. Return From Repair

a. Navy Designated Overhaul Point

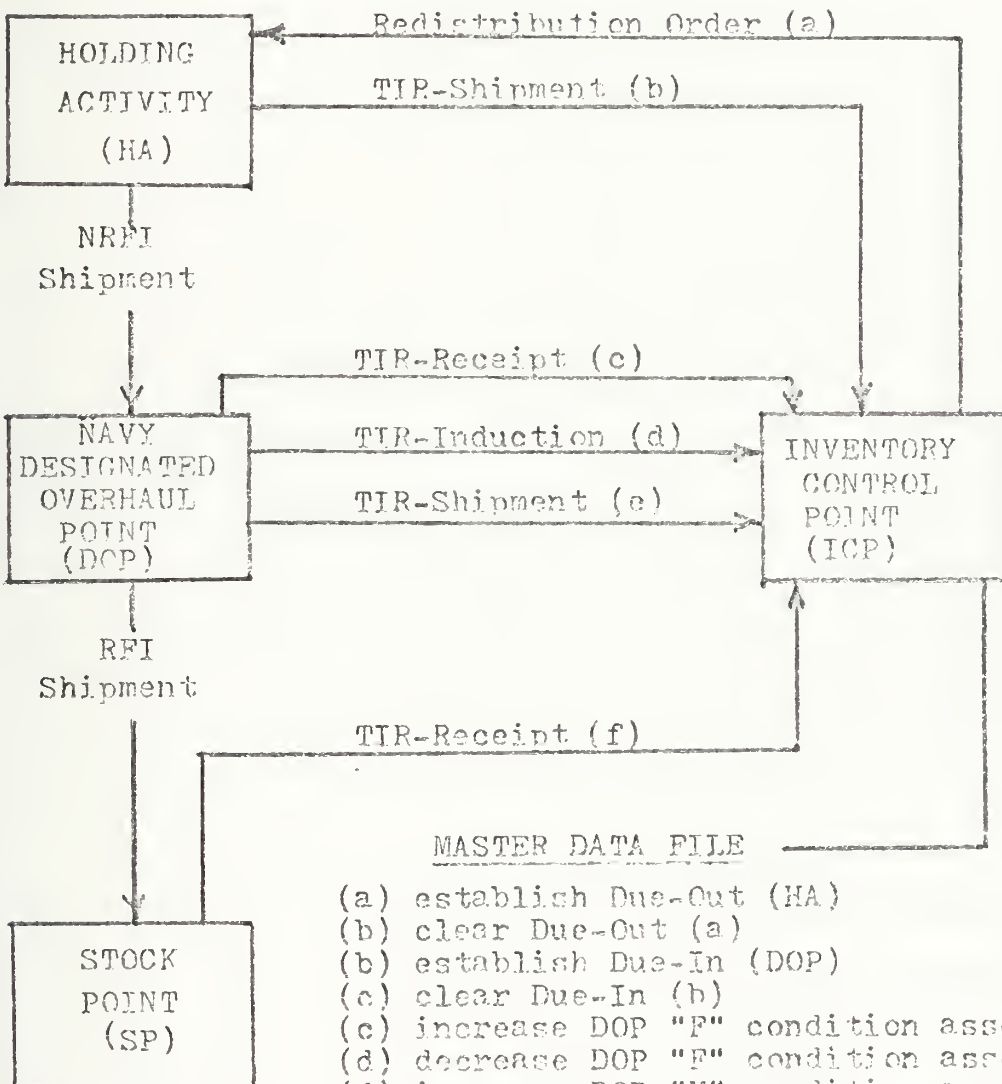
When the carcass has been completely overhauled and tested, it is ready to be placed in the RFI asset inventory. The DOP will ship all of the overhauled RFI carcasses as directed by the ICP. Normally, these assets are shipped to the Primary and Secondary stock points (Note: these assets can also be used to fill existing backorders or be prepositioned for future PHM/FFG overhauls). In either case, a TIR is generated when the RFI item is shipped to a designated location. This TIR establishes an Activity Due-In record on the MDF for the activity/activities designated to receive the RFI item. Upon receipt at the final destination, a TIR is generated which increases the "A" condition On-Hand Quantity for the receiving activity and decreases the "M" condition On-Hand Quantity for the DOP ("M" to "A" Condition Code transfer). This transaction establishes a final audit trail for follow-up/shipping data as previously discussed. The asset is now visible to the ICP in a RFI condition and is available for issue. Upon issue of this RFI asset, the entire repair cycle is repeated.

Figures (10) and (11) illustrate the monitoring techniques associated with the actual repair cycle.

b. Commercial Designated Overhaul Point

Receipts from Commercial DOP's will follow the same procedure as outlined above except that PMRC card

REPAIR AT NAVY DESIGNATED OVERHAUL POINTS



MASTER DATA FILE

(a) establish Due-Out (HA)
(b) clear Due-Out (a)
(b) establish Due-In (DOP)
(c) clear Due-In (b)
(c) increase DOP "F" condition assets
(d) decrease DOP "F" condition assets
(d) increase DOP "M" condition assets
(e) establish Due-In (SP)
(f) clear Due-In (e)
(f) increase "A" condition assets (SP)
(f) decrease "M" condition assets (DOP)

FIGURE 10

REPAIR AT COMMERCIAL DESIGNATED OVERHAUL POINTS

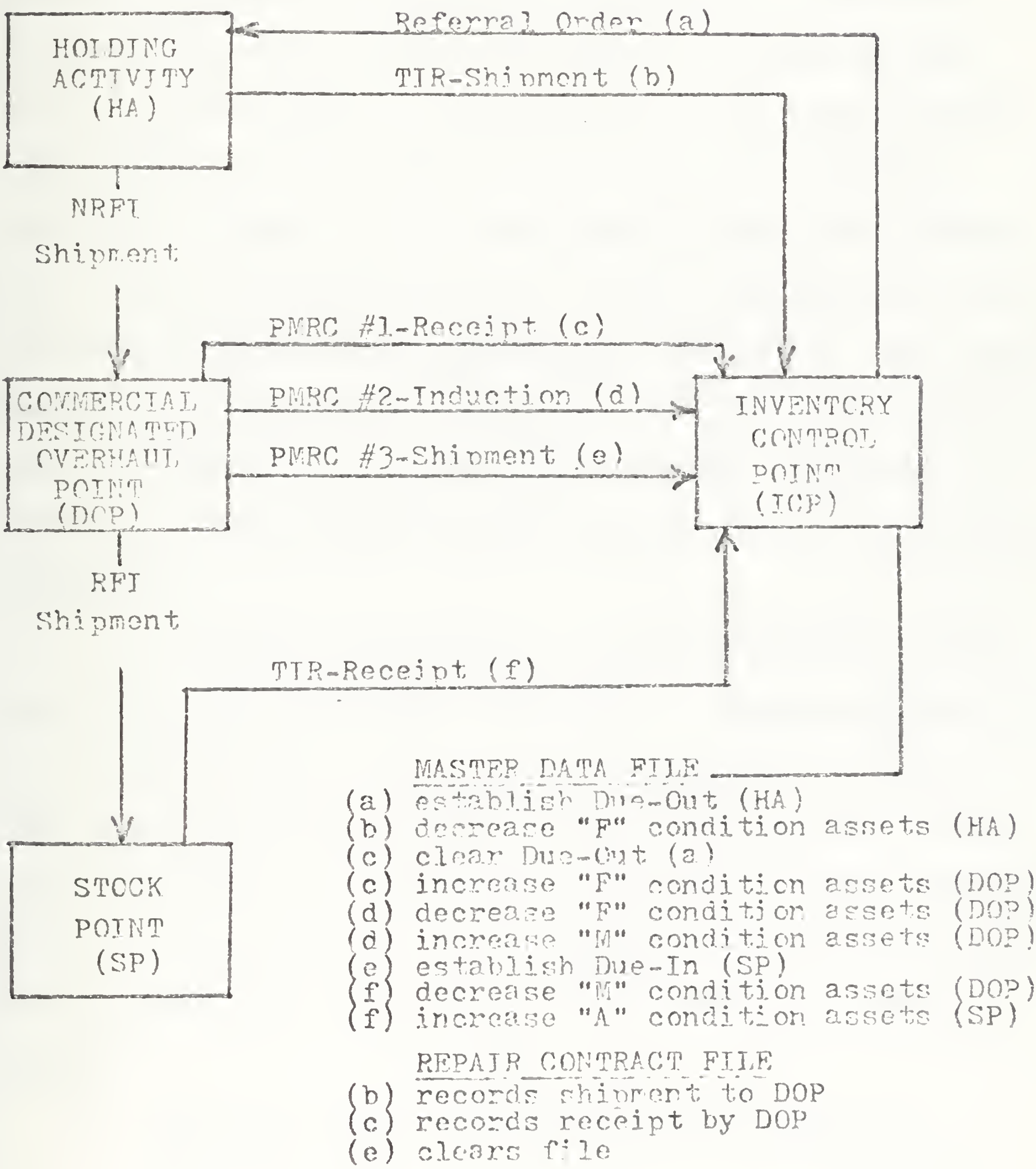


FIGURE 11

number 3 will be used to report the completion of repair vice the TIR.

5. Management Reports

The monitoring system described above can be implemented within the present computerized Repairables Monitoring System at SPCC and should be compatible with any new system that may be introduced by the IRAM program. Consequently, all of the present reports generated by SPCC will be applicable to the overall Repairables Management Information System as well as the additional activity performance and follow-up techniques described. The proposed monitoring system will provide precise, definitive information and should be utilized within standard programs to evaluate the performance of the overall system and individual activities.

To ensure the accuracy of total available system stock assets on the Master Data File, a reconciliation of all condition coded assets should be conducted annually. This reconciliation should take place between the ICP and all Transaction Item Reporting activities and the Commercial DOP's. The success of this reconciliation is another method of evaluating the performance of the repairable reporting system.

6. Fleet Repairables Assistance Agents (FRAA's)

Under the Improved Repairables Asset Management (IRAM) program, monitoring personnel will be stationed at key transshipment and stock points (noted in V, C).

The Fleet Repairables Assistance Agents (FRAA's) will be primarily responsible for expediting the movement of retrograde NRFI repairable carcasses through the major transshipment and stock points. The following duties should be assigned to the FRAA's:

a. aid in the identification and transshipment of carcasses
b. assist fleet units in packing and crating carcasses for shipment
c. examine turn-ins for adequacy of physical protection and adequate documentation
d. monitor cargo between MAC, QUICKTRANS and commercial terminals
e. arrange for over-the-road trucking transportation between relatively short distances where air transportation is not readily available
f. screen all unserviceable returns for possible survey.

VI. THE MODEL

A. BACKGROUND

The overall objective of this thesis was to design a total distribution system for the repairable assets of the LO-MIX program. In order to provide a total system, it was deemed necessary to determine a means whereby operating policies for the system could be devised and tested. A thorough review of the available literature revealed that there were no inventory models available which fit the complexities of the LO-MIX system. While there are many models of varying sophistication available, the complexities of the actual distribution system would render any results from application of existing models questionable if not useless. This meant a new model had to be devised.

The question then arose as to what type of model was most appropriate. Since there were no "off the shelf" prescriptive models available to provide optimal solutions for the LO-MIX system, it was decided to develop a heuristic model which would allow the inventory managers to propose inventory policies and then, through simulation, to evaluate the effects of such doctrine on the system itself. With the extremely complex multi-echelon system proposed it became obvious that a simulation would provide the best means of dealing with the many variables. A simulation also offers a great deal of flexibility which

is extremely desirable considering the range of problems the model is expected to address.

Due to time constraints the actual coding could not be accomplished. This meant the model must be presented in some easily understood format which could be readily converted into a computer program. The flowchart format was chosen for these reasons and though appearing somewhat complicated at times, the following explanation should render it quite suitable both for the reader and the programmer.

B. BASIC ASSUMPTIONS

In order to model an extremely complex system such as that for the LO-MIX repairables invariably some assumptions must be made. As a general rule the less restrictive the assumptions the more accurately the results reflect the real world system but the more complicated the model becomes. The basic assumptions listed below are not considered extremely restrictive and justifications for them are included. Furthermore the model is not considered overly complicated and should be relatively easy to program. The assumptions underlying the formulation of the model are:

1. The model will be programmed for a computer.
2. Historic data on failures, transportation times, repair times, etc. provide a sound basis for future behavior.

3. The ships remain in one general area throughout the run.
4. Item failures are a function of time and are not affected by nonoperating periods such as overhauls.
5. Items are ordered and repaired on a one for one basis to replace inventories and failed units.
6. The system will provide transaction reporting so that the condition of all units is known and the unit location is available at all times except when in transit.

Some explanation may be in order at this point for several of these assumptions. It is felt that computer programming provides the only means of handling the complexities of this system. In this light the terms model and program are used interchangeably throughout the discussion.

Historic data may not accurately predict the future but it certainly provides a good indicator for future expectations. If the sample size is large, the information is accurate and current, and the conditions remain basically the same then this assumption is felt to be valid.

While it is recognized that ships deploy and relieve each other quite regularly, the model is not affected as long as the numbers in each area remain the same. The model will deal with area ship population changes only as ships are introduced into the fleet not as the deployment schedule dictates. If the number of ships in the various

operating areas is to change, other than as new ships are introduced, the changes will have to be input as a separate simulation run.

It can certainly be argued that failures occur as a function of operating time and not clock time. In any event the yard periods which constitute the only non-operational time for model purposes are short and infrequent therefore they are ignored.

The one for one replacement and repair policy is used considering the high cost of repairable units and the larger inventory necessary to batch process. It is possible that the units will be batched for repair but if this occurs the difference will be reflected in the repair time distribution and will not detract significantly from the results of the model.

Transaction reporting is used for high value items and is strongly recommended by the authors for the LO-MIX repairables. The monitoring system previously presented is of this type.

The discussion will now turn to a brief general description of the model prior to a more detailed explanation.

C. GENERAL DESCRIPTION

The model provides a means of testing operating policies for a specified number of days. It is meant to be run for each repairable item utilized by the LO-MIX ships and will simulate the operation of the actual distribution system over time. At yearly intervals it will output

data to allow the user to assess the effectiveness of his policies. By changing the inputs which determine the operating rules for the system he can make successive runs until he is satisfied that, though maybe not optimum, the rules he has developed for the particular item are acceptable. Due to the simularities of many items the process should not be as overpowering as it might first appear.

The model is designed to utilize a series of files containing individual records with fields of data necessary to determine and carry out the basic actions that would occur in the actual system. The records, to be further described in a following section, contain both fields of input data and fields for the storage of data necessary for the internal manipulations of the program. The decision as to computer locations of these files is left to the programmer and will undoubtedly be a function of the computer time involved and core storage capacity of the machine as well as the language employed. In addition, the routines are presented in the most easily understood manner with no claim to computer efficiency. It is the belief of this research team that these considerations are best left to the programmer with his knowledge of the particular computer and language to be used.

The data files include a site file, a ship file, an event stack, an inactive stack, a miscellaneous (MISC) file, a repair level file and a transportation (TRANS) file. The site file provides the data necessary for each

individual site that might have units in stock, be a turn-in point, or utilize units for programmed maintenance. The ship file provides the data needed for each ships usage and requisitioning procedure. The event stack contains the individual stack records for further use. The MISC file provides an input/storage vehicle for various information used throughout the routines. The repair level file provides the distribution information necessary to determine the loss or level of repair for a failed item. The transportation file includes the distribution information necessary for the determination of the time each unit will spend in transit over the various transportation legs.

The program is run over a specified number of periods (RUN PERIOD) which is an input at the start of the run. The periods correspond to days, kept internally by the CLOCK, and on each day the necessary actions are taken to simulate the events that will occur in the real system. These events are simulated through a Monte Carlo process utilizing historic distributions of the times applicable to each event. A random digit is generated to designated where in the distribution of interest any single event will occur for the purposes of that particular action. These events are kept in an event stack which is maintained so that the events are in chronological order. In addition, the ready-for-issue deliveries (RFI DEL) occur first and then the backorders (BACKORDER) are filled prior to other events on any given day. This requires that these records

be stacked first for a given clock time which poses no real problem since stack routines are quite easily processed.

Initially the program inputs the data and initiates stack records to reflect the projected failure times of the units installed on the ships at the time of introduction into the fleet. It then queries the stack for any actions necessary on the clock day. The time when the actions are to occur are either predetermined by the inputs or drawn from the Monte Carlo process as previously discussed. If any stack records are coded for action on that day the actions are completed. The action codes are ready-for-issue delivery (RFI DEL), failure (FAILURE), programmed maintenance action (PMA), backorder (BACKORDER), not-ready-for-issue delivery (NRFI DEL), procurement (PROCUREMENT), initial stockage/programmed maintenance (STOCK/PMS).

These various routines are fully described in a later section but a brief description may be in order at this point. A RFI DEL can be an item out of repair, arriving from a procurement, or arriving from transit. The item is either put into inventory or, if reaching a ship which is missing an item (NORS), it is installed and a stack record is generated for its projected failure time. A failure causes a stack record to be generated for the turn-in of the NRFI unit (NRFI DEL) and a determination as to the loss or maintenance level at which it will be repaired. It then orders a RFI part (RFI DEL) to replace

the unit through a designated series of inventory points and will order replacement stock for these points if necessary. If no unit is found the action then becomes a backorder (BACKORDER) until a part becomes available. A programmed maintenance action involves replacement of the units on the periodic maintenance schedule and generation of stack record for the projected failure time of the new unit as well as the turn-in of the old unit for repair. The backorder routine checks the stock of the inventory point until a unit becomes available and then initiates a stack record for the RFI DEL. The not-ready-for-issue delivery (NRFI DEL) either puts the unit in repair or makes a stack record to ship it to the correct repair facility if it is beyond the maintenance capability of the arrival site. The procurement routine generates stack records for the delivery of the new units after the procurement lead time (PCLT) has passed. The initial stockage/programmed maintenance (STOCK/PMS) routine generates stack records to ship parts to programmed maintenance sites and to the stock points for their initial stocks.

When the days events have been completed the program carries out the computations necessary to accumulate the data for later output. It then determines if it has reached the end of the clock year. If not it adds one to the clock and again checks the stack for events requiring action. If it is the end of a year it prints the information which is used for determination of the effectiveness

of the operating policies utilized during the run. The program then checks to see if it has completed the desired run period and if so will stop. If the period is not over it again adds one to CLOCK and checks the stack for events requiring action for the first day of the succeeding year. A flowchart representation of this functional overview is presented in figure (12) and a procedural overview follows in figure (13).

With this brief description as background a more detailed discussion of the inputs required for program execution follows. The individual routines and the outputs are presented separately and are followed by the proposed applications of the model.

D. INPUTS

The inputs are in the form of records with each field of data having a specific purpose. In order to present the model in the flowchart format it was necessary to code the fields of data. The code words chosen met only two criteria and those were that they be short enough to fit in the flowchart symbols and descriptive enough so the authors could keep track of them. It is hoped that the following discussion adequately explains their meaning in the context of the model.

Many of the inputs such as failure rates, repair times, repair level or loss, and operating schedules will initially have to be estimates based on the best information available. This information, while certainly not totally

FUNCTIONAL OVERVIEW

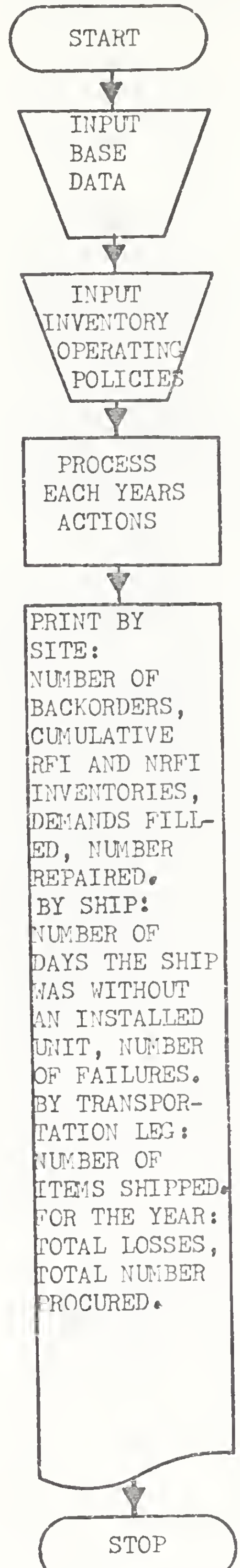


FIGURE 12

PROCEDURAL OVERVIEW

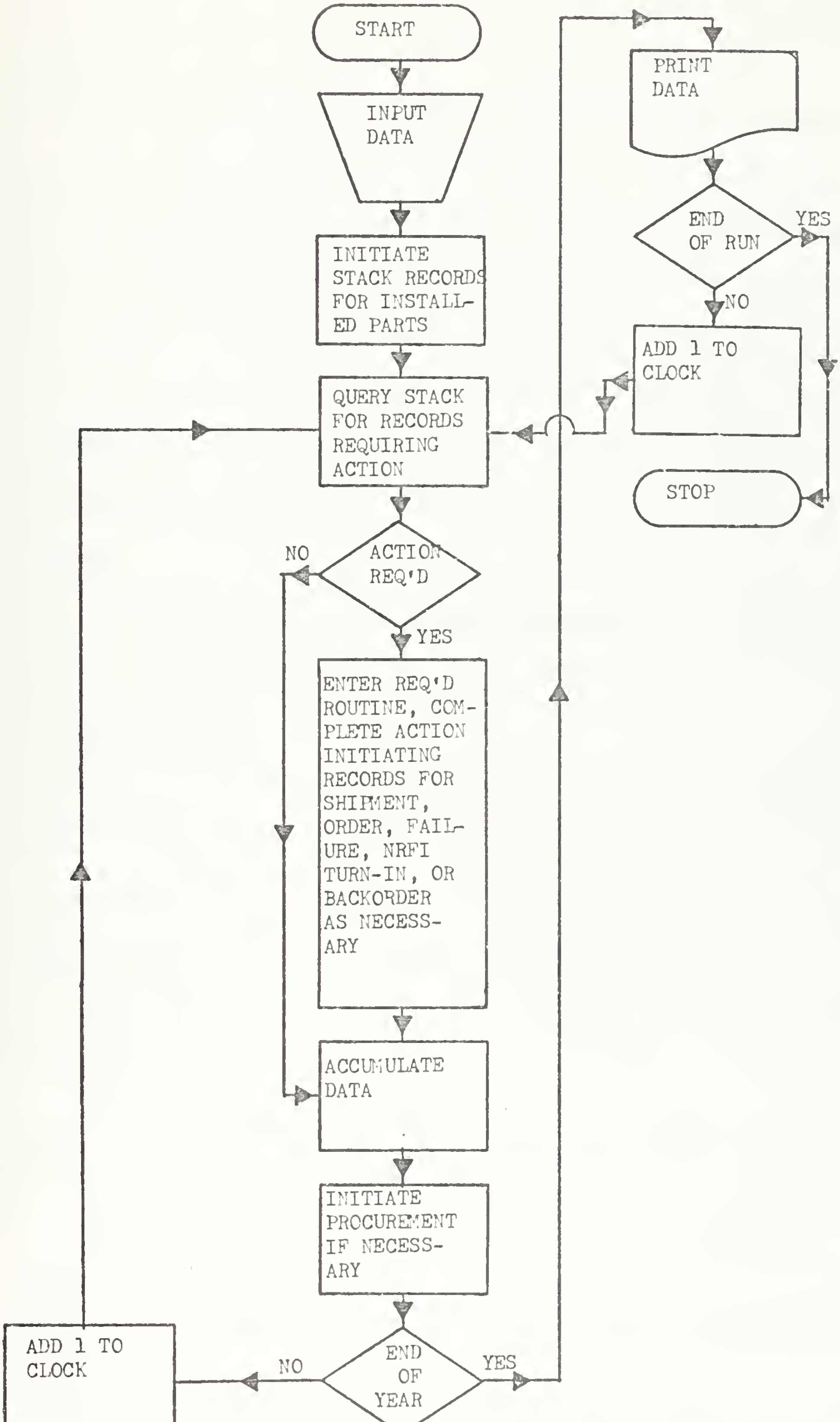


FIGURE 13

accurate, will provide a reasonably meaningful base for runs until the information derived from the operation of the actual system can be refined enough for use in the model. The monitoring system reports will eventually provide the necessary information for developing historic data for all of these parameters as well as the transportation times experienced by the LO-MIX repairables. It is strongly recommended that as the information system is developed the need for this data be given special consideration and a program be devised to extract it in a usable form.

This section presents the various records and describes the meaning and uses of the fields of data.

1. <u>Site Record</u>

There is a record in the site file for each site which will be utilized in the run for either holding inventory, locating a turn-in point for NRFI units, or performing periodic maintenance. This may also include the AFS's if they are to be utilized in the system. The code words and explanations follow:

SITE CODE	Code assigned to each individual site.
RFI INV	The number of ready for issue units in stock at the site. Initially input as zero.
NRFI INV	The number of not-ready-for-issue units in repair at the site. Initially input as zero.
ORDER FROM 1 through 4	The sites to which this particular site will go to order RFI units. They are input in the order of preference by the program user.

BACKORDER	The cumulative number of clock days that a demand was placed on the site which it could not fill. Initially input as zero.
REPAIRED	The number of units repaired at the site. Initially input as zero.
DEMANDS	The cumulative demands filled by the site. Initially input as zero.
MAX INV	The maximum inventory of RFI units allowed to accumulate at a site before they are transshipped. The program will automatically ship any units in excess of this number to the ORDER FROM 1 site.
REPAIR CAPABILITY	The repair capability of the site. Input as D (Depot), I (Intermediate), or N (None). Primary stock points are considered to have D capability even if they ship the NRFI units to another point for repair. The repair time distribution information then becomes the time from the arrival of the NRFI unit at the stock point until its return in RFI condition.
BCM TO	The site where an NRFI unit beyond this particular sites maintenance capability should be shipped.
SUM RFI INV	The cumulative total of each days RFI inventory. This number when divided by the number of days run gives the average inventory. Initially input as zero.
SUM NRFI INV	Same as above for NRFI inventory.
REPAIR TIME DIST	The distribution of repair times experienced by the site. This will have to be an estimate on the users part until the data base from the monitoring system provides actual historic data. The time of interest is the time from arrival at the site of the NRFI unit until its return to the shelf in RFI condition.

2. Ship Record

There is a record in the ship file for each ship in the fleet. The program allows their introduction over time even though all records are input at the start of the

run. The ships operating areas are defined by the points they order from and ship NRFI units to and by their item failure rates which are based on operating time. The ships are assumed to remain in one operating area even though it is recognized that they do relieve each other in certain areas (see basic assumptions for justification). The data fields follow:

SHIP CODE	Code assigned to each ship.
INVENTORY	The number of RFI units in stock. Initially input as zero.
IG-1 ORDER FROM	The point from which units are ordered to replace failed units if the ship has none in stock and the AFS is not utilized or out of stock.
IG-2/3 ORDER FROM	The point from which units are ordered to replace ship stock.
AFS	This indicates the availability of an AFS for parts replacement. Coded by placing the site code of the AFS in the field.
SHIP TO	The point where NRFI units are shipped.
FAILURES	The cumulative number of failures experienced by the ship. Initially input as zero.
NORS	A code to indicate that the ship has had a failure for which a replacement has not been received. Initially input as zero.
INTRO DATE	The date the ship will enter the fleet.
ITEMS PER SHIP	The number of the particular item of interest for this run installed aboard the ship.
MIN OPS TIME	The minimum operating days on a unit for replacement at the scheduled maintenance interval. If this number of days is not exceeded the unit will not be replaced.

SUM NORS	The total number of days the ship was without a RFI unit to replace a failed unit. Initially input as zero.
COAST	The coast on which the ship operates. Input as E or W.
FAIL TIME DIST	The distribution of times experienced between item failures on ships operating under the projected operating schedules for the run. This will initially have to be an estimate based on the mean time between failure information and the projected schedule but the data base provided by computer inputing the information from the monitoring system will eventually provide it.

3. Stack Record

There is a stack record in the event stack for each occurrence which would trigger actions by the routines in the model. In addition there are a number of inactive stack records for use when a routine calls for the generation of a new record. The records provide a means of storing actions to occur in the future with all the information necessary to complete the action.

The initial inputs for the program require a number of stack records. A record must be input for each scheduled procurement. These procurements will occur over time as more ships and inventory sites are added. They are input with a stack code to initiate the action in time for the units to arrive at the primary stock points as desired. Another stack record must be input for the time of each shipment needed to provide the programmed maintenance sites with units for scheduled maintenance. Finally a stack record must be input to provide

for shipments of units to provide the initial stock for all inventory sites except the primary stock points which are initially stocked by procurements.

The information contained on the stack records follows:

STACK CODE	The code assigned to each record to indicate the clock time when action must be taken.
ACTION CODE	The code assigned to indicate the type of action necessary and the routine to go to for the completion of that action. The possibilities are RFI DEL, FAILURE, PMA, BACKORDER, NRFI DEL, PROCUREMENT, AND STOCK/PMS.
DEST CODE	This is a ship or site code assigned to indicate the destination of a shipment or an action.
ORIGIN CODE	This is the ship or site code assigned to indicate the origin of a shipment or action.
INSTALL CODE	This is the ship code assigned to indicate the ship on which a programmed maintenance unit will be installed. It is only used for STOCK/PMS action coded records.
DATE INSTALLED	This is a clock time, carried on FAILURE coded records only, which indicates the clock day on which the unit was installed aboard the ship. This is the first day a unit is available at the ship after a failure.
REPAIR CODE	This is used on NRFI DEL coded records to indicate the level of repair or loss of a unit. It is either I (intermediate), D (depot), or L (loss).
PC ORDER SIZE	Input on PROCUREMENT Coded records to indicate the number of units to be ordered.
ITEM NUMBER	If there is more than one unit installed on each ship the units will be numbered.
REORDER	This is used internally by the program to determine whether replacement units will

be ordered when units are shipped out to fill demands.

4. Repair Level Record

The repair level file consists of just one record which gives the distribution of the repair levels and loss rates experienced in the past. When a unit fails it is either lost or it can be repaired at the intermediate or depot level. Some units are designated repairable at the depot level only and the distribution information should reflect this. As the data base from the monitoring system develops this information will become readily available however, until that time it will have to be the best information available based on system planning and item design.

The data field for the repair level record is coded as follows:

REPAIR LEVEL DIST	The distribution of repair level and loss information experienced on failed items.

5. Transportation Record

The transportation file (TRANS FILE) consists of records for each transportation leg to be used in the run. There is a separate record for each direction over the leg because past experience has shown that the actual times can differ significantly.

In researching the material for this thesis it became apparent that much of the success or failure of the entire LO-MIX concept would depend on rapid and dependable transportation. In view of this, attempts were made to

find sources from which the necessary data could be drawn until the distribution systems data base could provide it. It was soon determined that in order to use this data in the planning phases of the system it would have to first be developed. Since it was considered essential to both the efforts of the authors and the early runs of the simulation model, the task was undertaken and the results follow.

The primary sources of transportation data were the Military Airlift Command (MAC) and the Navy Material Transportation Office (NAVMTO) in Norfolk. The Military Airlift Command provides airlift into and out of CONUS for all Department of Defense activities. NAVMTO, a NAVSUP field activity, is the nerve center for QUICKTRANS, a contractor-operated CONUS-wide airfreight and truck system.

Brief investigation into the use of Military Sealift Command channels for the transportation of parts immediately revealed that this mode of transportation was significantly less adequate than the MAC airlift for Atlantic and Pacific transits.

a. MAC Data

Data on various MAC channels was provided by Military Airlift Command Headquarters, Scott Air Force Base, Illinois. Of primary interest were port hold times (PHT) at manifesting terminals. It was assumed that the actual in-transit time of the cargo would be

relatively constant. That is, the flight times and scheduled ground times as appearing in the MAC schedules would be subject to little change. The largest variable would be the port hold time. Port hold time is defined as the time elapsed between receipt at a MAC terminal and actual lift aboard the MAC aircraft. It is the port hold time that may be controlled and/or manipulated by local transshipment planning and procedures.

Port hold time data was provided in a very useful format (i.e., by transportation priority in hour by hour accumulations) by the Movements & Reports Division of MAC Headquarters (see Appendix B). The data was retrieved from the Transportation Information Processing System (TIPS) specifically for our purposes.

Mean port hold times were computed from the data provided. MAC Headquarters qualified the data they provided stating that some of the port hold times were highly suspect due to some internal difficulties in their data base in the early months of the data period used in our study. For instance, there were transportation priority one shipments at Travis Air Force Base destined for Cubi Pt.,, P.I. with port hold times indicated in excess of 800 hours (34+ days). While data of this type was not encountered often, it is worthy of note since these figures were included in the computation of mean port hold times. Since it was nearly impossible to determine whether or not such exorbitant port hold times

were erroneous or in fact actual delays, they are included in the data presentation. It was considered more appropriate to handle the suspicious data in this manner rather than select an arbitrary limit to port hold time data. The result is mean port hold times that may tend to be somewhat high.

The port hold time data used was for cargo of all services moved in the selected channels during the period July-December 1974. All service cargo data was used vice strictly Navy cargo data since cargo is moved according to transportation priority assignment regardless of service of origin (Army, Navy, etc.). Also, use of this overall data provides a large sample size.

Scheduled flight time and ground time were taken from the MAC Cargo Schedules, January 1975. The aircrafts utilized for the channel airlift are the C-141 Starlifter and the C-5A Galaxy. The C-141 has a maximum cargo capacity of 68,500 lbs. for 4,210 miles. The C-5A can carry 174,000 lbs. for 4,210 miles. (Commanders Digest, 10)

b. QUICKTRANS Data

The data presented concerning those channels or portions thereof serviced by QUICKTRANS is based upon a mean time and a minimum time of the total service between specific points. The Naval Material Transportation Office, at the time of writing, was undergoing major changes to their information system and was unable to provide more detailed information in the form of hold time distributions.

Based upon manual computation utilizing some 100+ Transportation Control & Movement Documents (DD-1384) for cargo moved during February - March 1975, a mean time between certain CONUS terminals was derived. This mean time is defined as the mean total time between receipt at the QUICKTRANS origin terminal and the time at the destination when the consignee has been notified that the shipment is ready for pick-up. Included in this time are palletization, manifesting, waiting and loading at origin, the transit time, and unloading and inspection at destination.

A minimum time is also provided. This time is provided for information and comparison only. It is the practical minimum time that the QUICKTRANS system could service the route in an urgent situation. It includes a reduced amount of time allotted to the processes mentioned above. This minimum time is not to be confused with the minimum total transport time to be described later. The mean and minimum times provided for QUICKTRANS segments apply to all priorities of cargo.

As previously mentioned, NAVMTO is upgrading their information system. The QUICKTRANS Computerized Information Improvement Program, if successful, promises to provide more specific performance data in the very near future. Installation of a Control Data Corporation model 3200 computer and improved software will reportedly provide improved information retrieval capability by July 1975.

The QUICKTRANS system moves cargo by both aircraft and truck. The aircraft servicing the channels discussed here are Hercules (L-100-30) airfreighters with a 46,000 lb. cargo capacity. Items up to 50 feet long with an 8 x 9 foot cross section may be loaded aboard. (Cunningham, 30-31) Saturn Airways is currently under contract for operation of the QUICKTRANS system.

QUICKTRANS scheduling information was taken from the QUICKTRANS Flight Schedule FY-75 dated 28 Feb 75 and the QUICKTRANS Feeder Truck Schedule dated 15 Oct 74.

c. Data Presentation

The data has been prepared and presented in order to serve two purposes. First, it is presented to enable the reader to get an overall picture of the entire channel. A diagram depicting each channel is provided. In some cases, there is more than one path between origin and destination. Aircraft flight and ground times as well as trucking times are provided along the routes. <u>The minimum total transport time</u>, a sum of flight, ground, and trucking times via the shortest route, is displayed. This minimum total transport time may be considered the theoretical minimum time required to actually move the cargo from origin to destination, including scheduled stops at intermediate points, assuming zero port hold time, handling time, and transshipment time.

At MAC terminal origins, the mean port hold time (Mean PHT) is provided for each priority of cargo for which sufficient data was available. Port hold time is essentially a function of flight frequency, vehicle cargo capacity, and handling efficiency at the terminal. It is in this area that dedicated facilities for transportation and/or transshipment may realize time savings.

For QUICKTRANS segments, the mean time and minimum time are listed. To repeat, this mean time for the QUICKTRANS segments includes the entire process of palletizing, manifesting, waiting, loading, transit, unloading, and inspecting at destination. The minimum time, a practical minimum time, is not to be confused with the minimum total transport time explained above.

The second purpose to be served by the data presentation is to facilitate its use in a computer simulation. To this end, the histograms which follow the channel descriptions are provided. A histogram depicting the number of shipments versus total transit time as well as a cumulative histogram by percentage of shipments is shown.

The total transit time graphed here is the total of the MAC port hold time, the MAC transit time, and the QUICKTRANS mean time (if a QUICKTRANS segment is involved).

For those channels that involve both MAC and QUICKTRANS segments, the histograms were constructed by

adding the mean time of the QUICKTRANS portion to a distribution of the MAC portion developed from the detailed MAC port hold time data. For example, a column in a histogram between the total transit time points of 4.5 and 5.5 days would represent the number of shipments (or cumulative percentage) whose total transit time, defined above was between 4.5 and 5.5 days. It must be noted that this addition of the mean QUICKTRANS time to each increment of the MAC distribution causes the initial column of each histogram to begin at a point on the total transit time scale that does not include lower feasible times. This base histogram time is the sum of the mean time for the QUICKTRANS leg plus the flight and ground times for the shortest MAC leg portion. Again, this is due to the lack of QUICKTRANS distribution data and the need to use the mean time as a constant in the construction of the histograms. It may logically be inferred that total transit times between the minimum total transport time and the base histogram time are possible. For computer simulation purposes, however, this treatment of the unrefined QUICKTRANS data in combination with the refined MAC data is reasonably useful. A set of histograms is provided for each priority of cargo for which a sufficient data sample was available.

For those exclusively QUICKTRANS channels, only the mean and minimum times are provided on the channel description. No histograms could be constructed for these channels with the data available at this time.

SYMBOLOGY USED IN TRANSPORTATION
DATA PRESENTATION

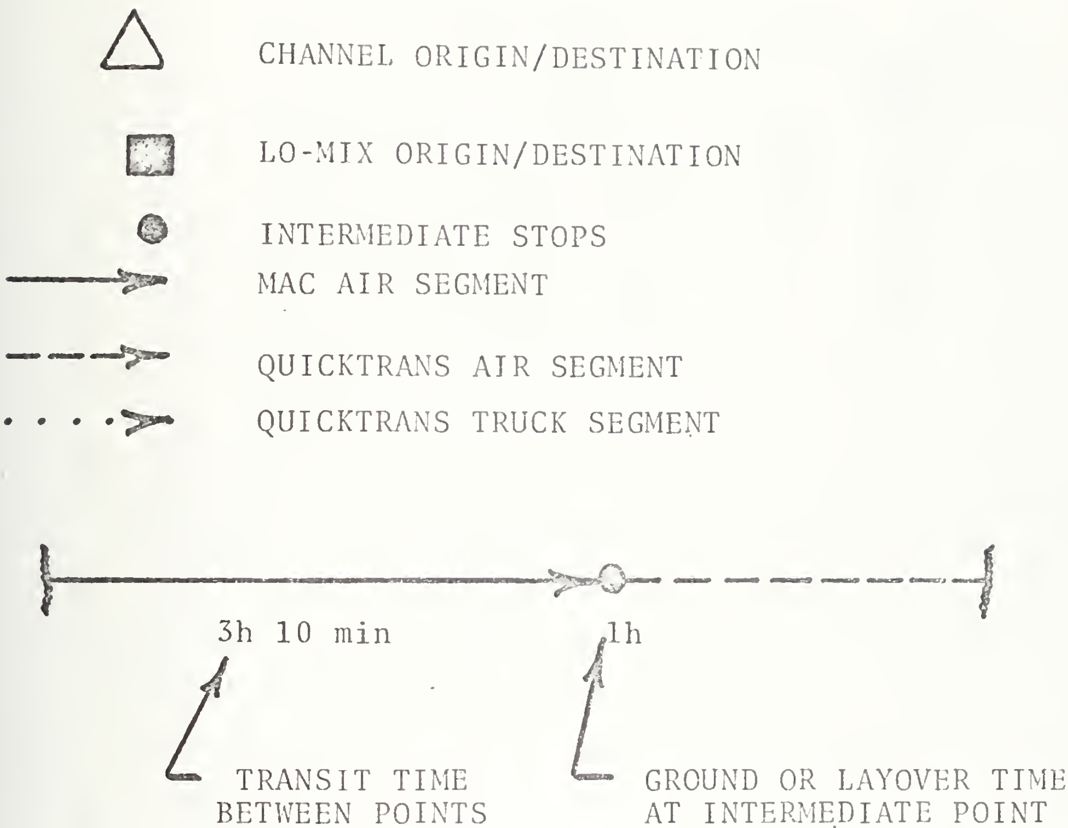


FIGURE 14

ANDERSON to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS)

Minimum total transport time = 15h 55min + 1h 50 min + 3h = 20h 45min = .86 day
Base histogram time = 15h 55min + 62h = 77h 55min = 3.25 day
(Pri-3 data sample insufficient)

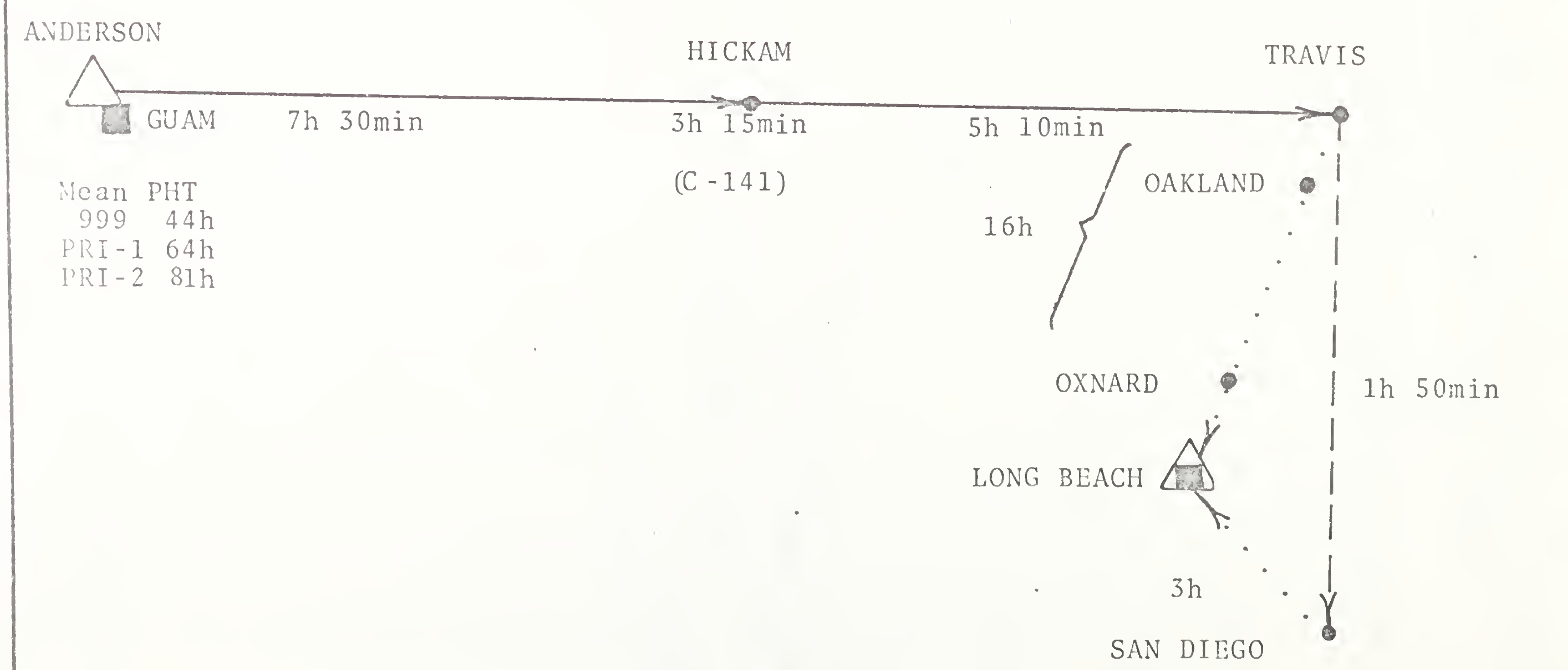


FIGURE 15

ANDERSON to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS)
999 CARGO Based on 300 shipments Jul-Dec 74
Minimum total transport time = 20h 45min = .86 day
Base histogram time = 77h 55min = 3.25 day

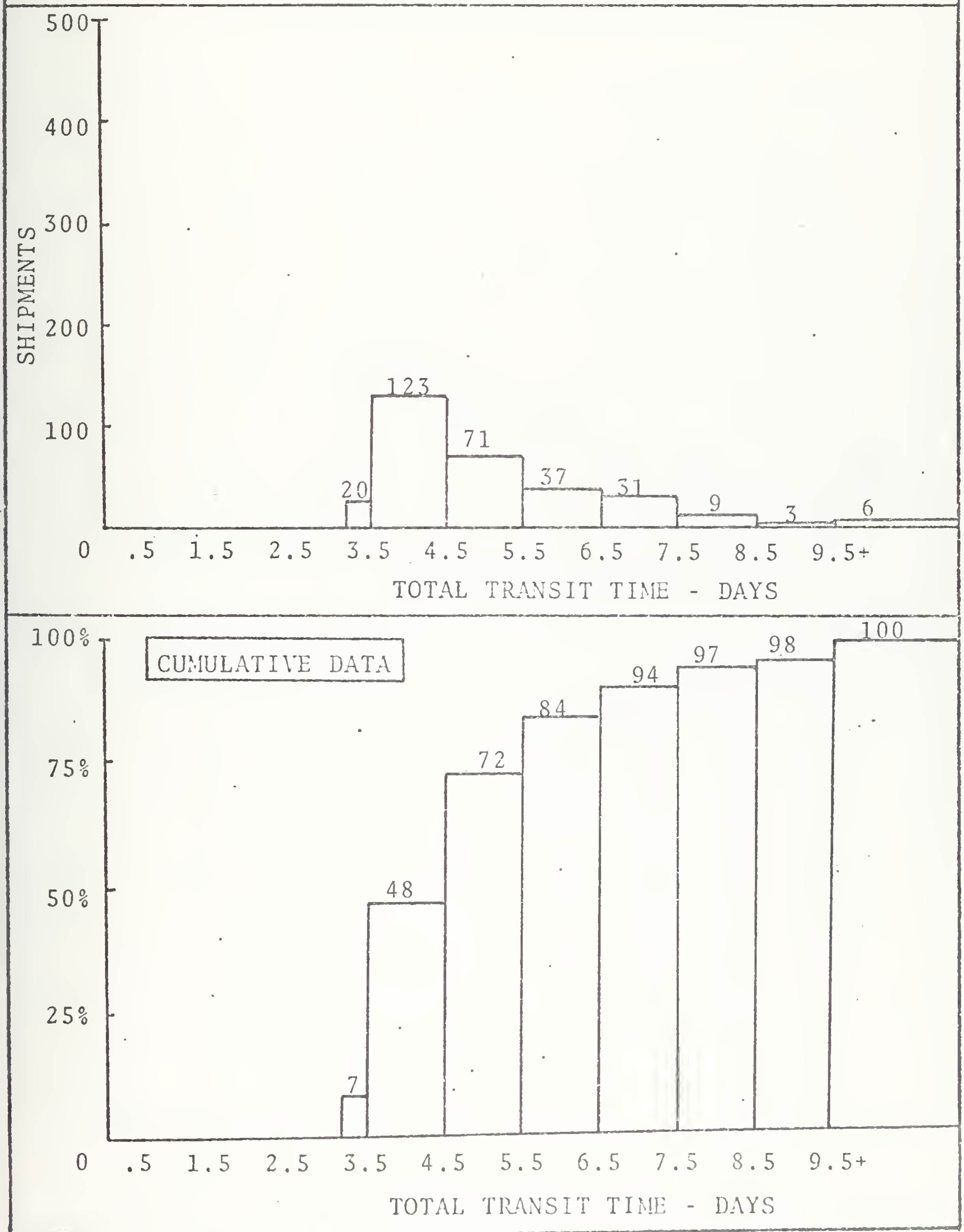
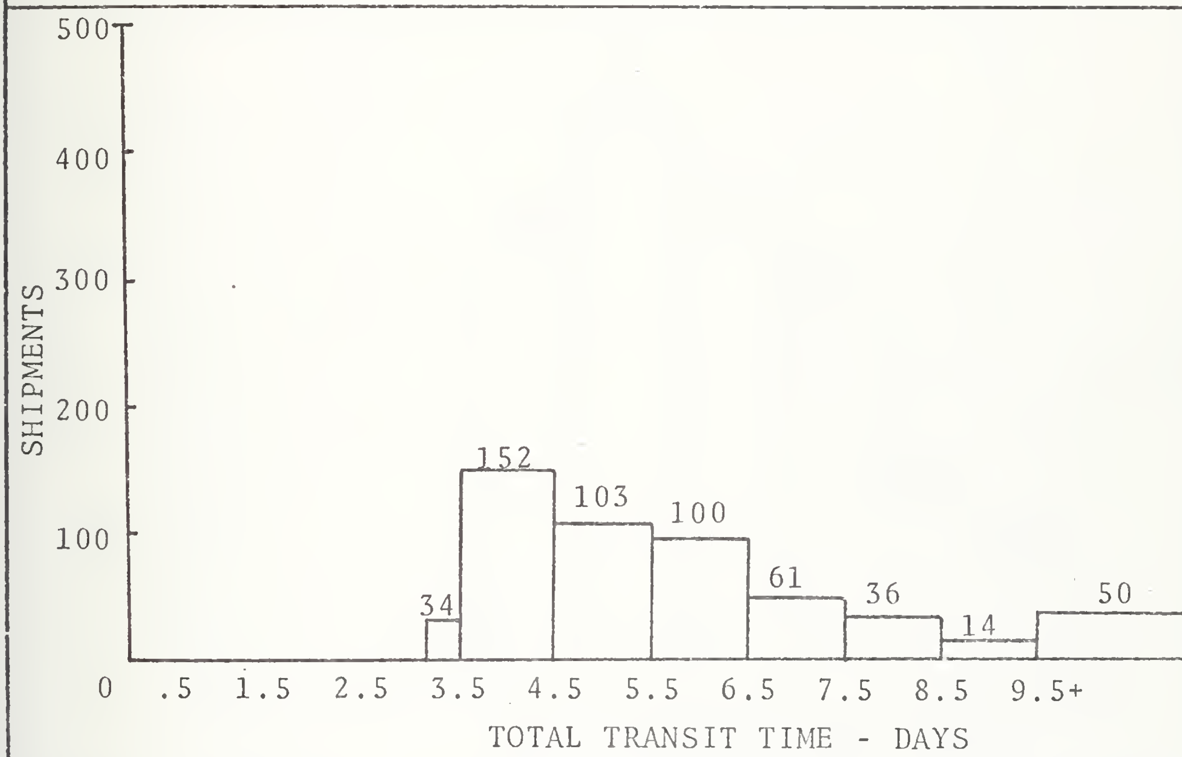


FIGURE 16

ANDERSON to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS)
PRIORITY 1 CARGO Based on 550 shipments Jul-Dec 74
Minimum total transport time = 20h 45min = .86 day
Base histogram time = 77h 55min = 3.25 day



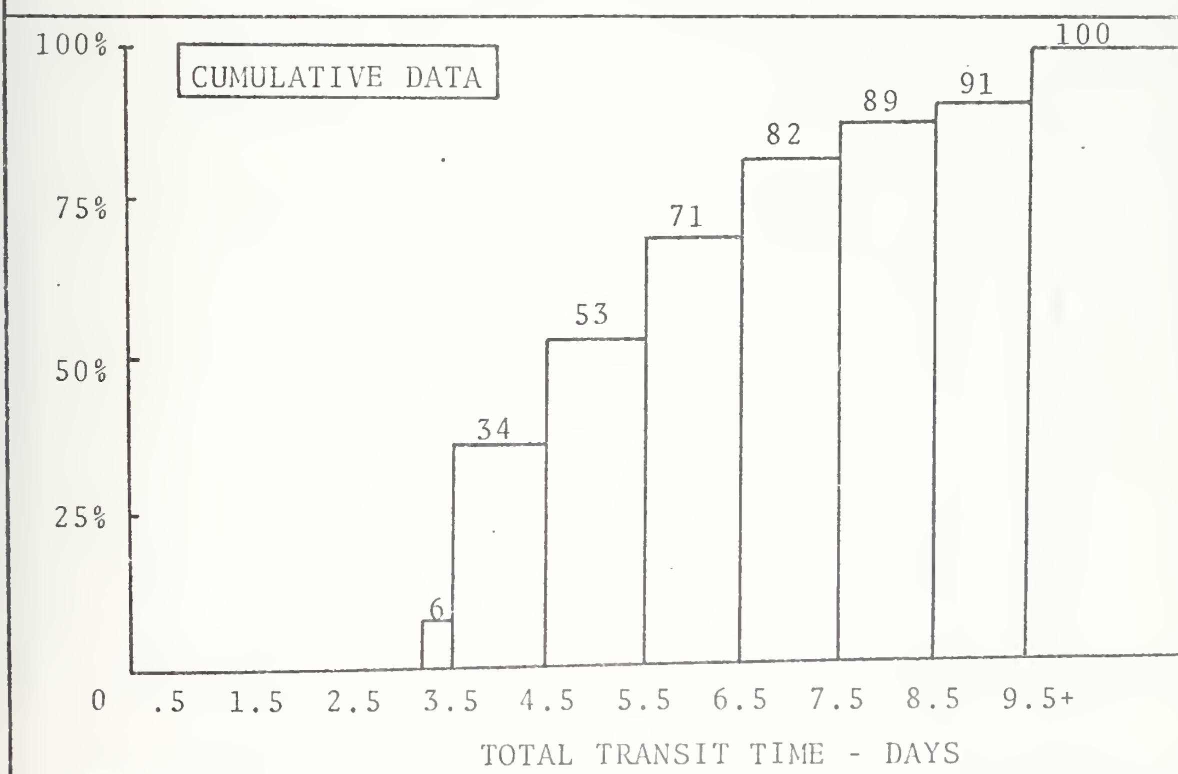


FIGURE 17

ANDERSON to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS)
PRIORITY 2 CARGO Based on 1901 shipments Jul-Dec 74
Minimum total transport time = 20h 45min = .86 day
Base histogram time = 77h 55min = 3.25 day

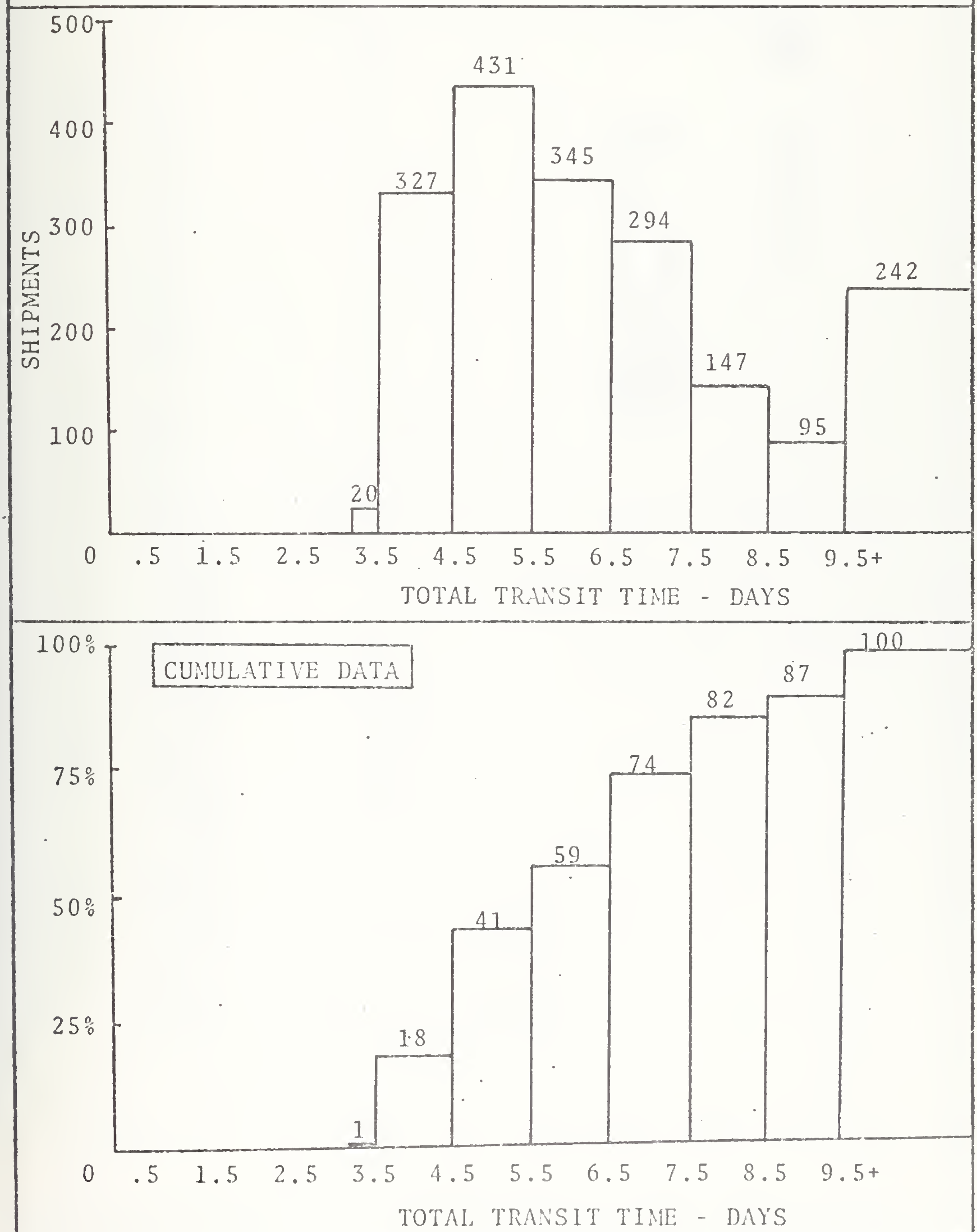


FIGURE 18

ANDERSON to TRAVIS (via MAC) to SAN DIEGO (via QUICKTRANS)

Minimum total transport time = 15h 55min + 1h 50min = 17h 45min = .74 day
Base histogram time = 15h 55min +18h = 33h 55min = 1.41 day
(PRI-3 data sample insufficient)

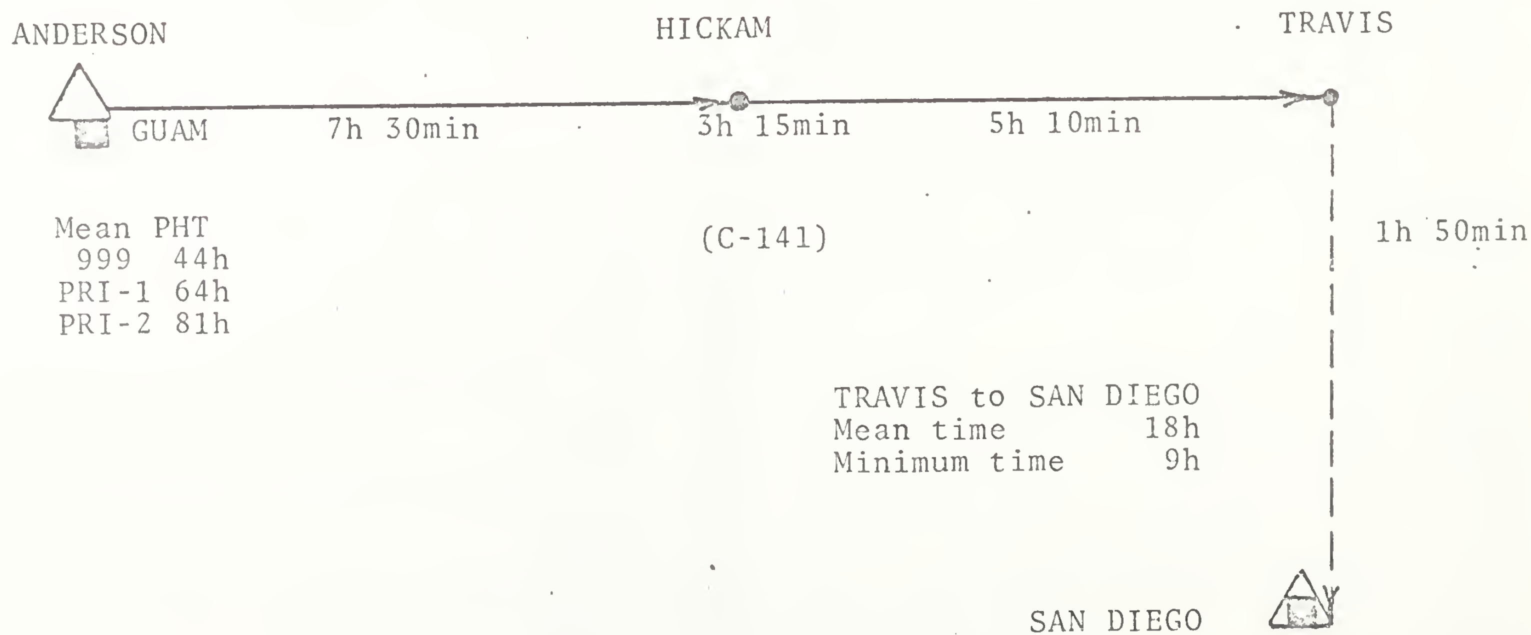


FIGURE 19

ANDERSON to TRAVIS (via MAC) to SAN DIEGO (via QUICKTRANS)
999 CARGO Based on 300 shipments Jul-Dec 74
Minimum total transport time = 17h 45min = .74 day
Base histogram time = 33h 55min = 1.41 day

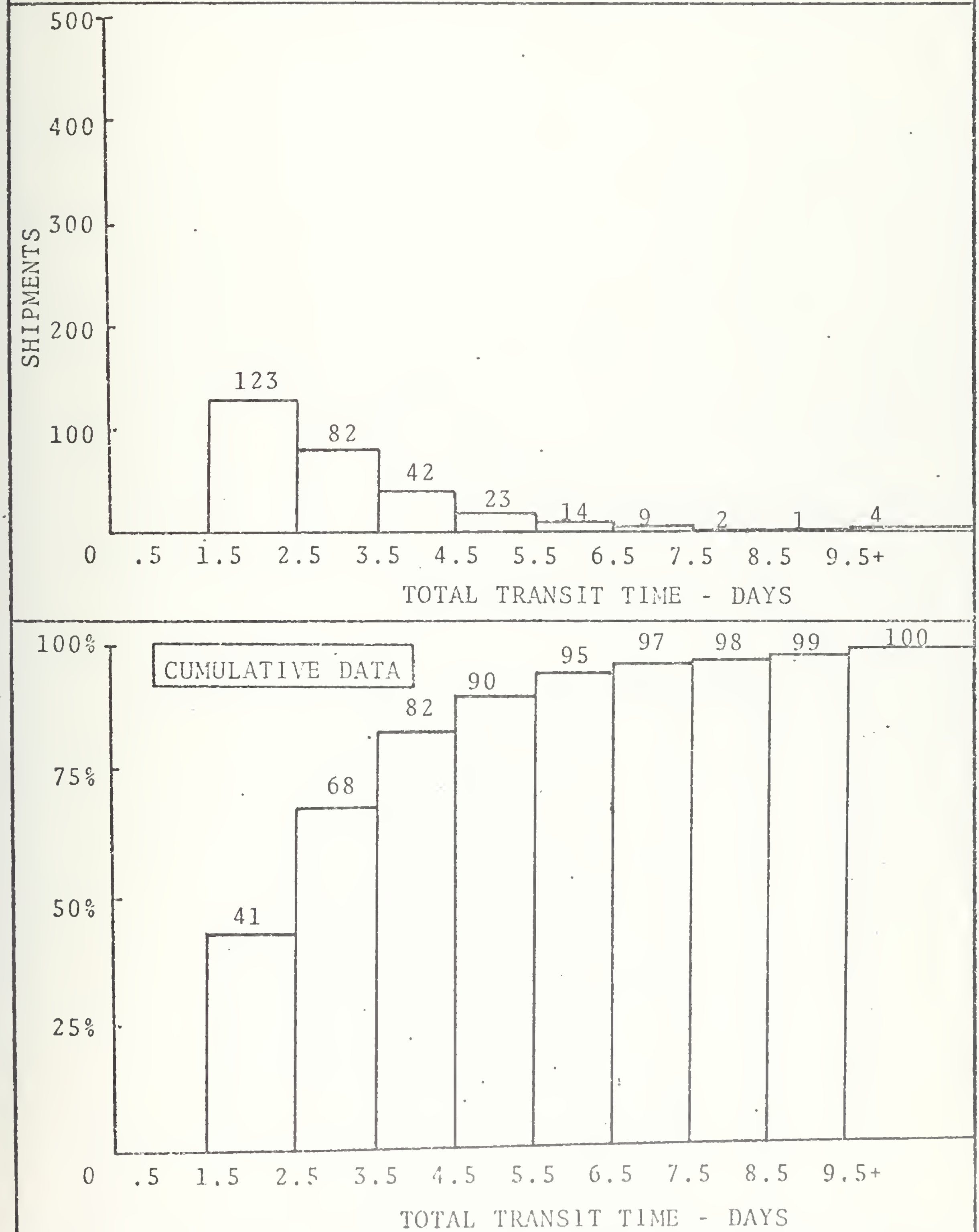


FIGURE 20

ANDERSON to TRAVIS (via MAC) to SAN DIEGO (via QUICKTRANS)
PRIORITY 1 CARGO Based on 550 shipments Jul-Dec 74
Minimum total transport time = 17h 45min = .74 day
Base histogram time = 33h 55min = 1.41 day

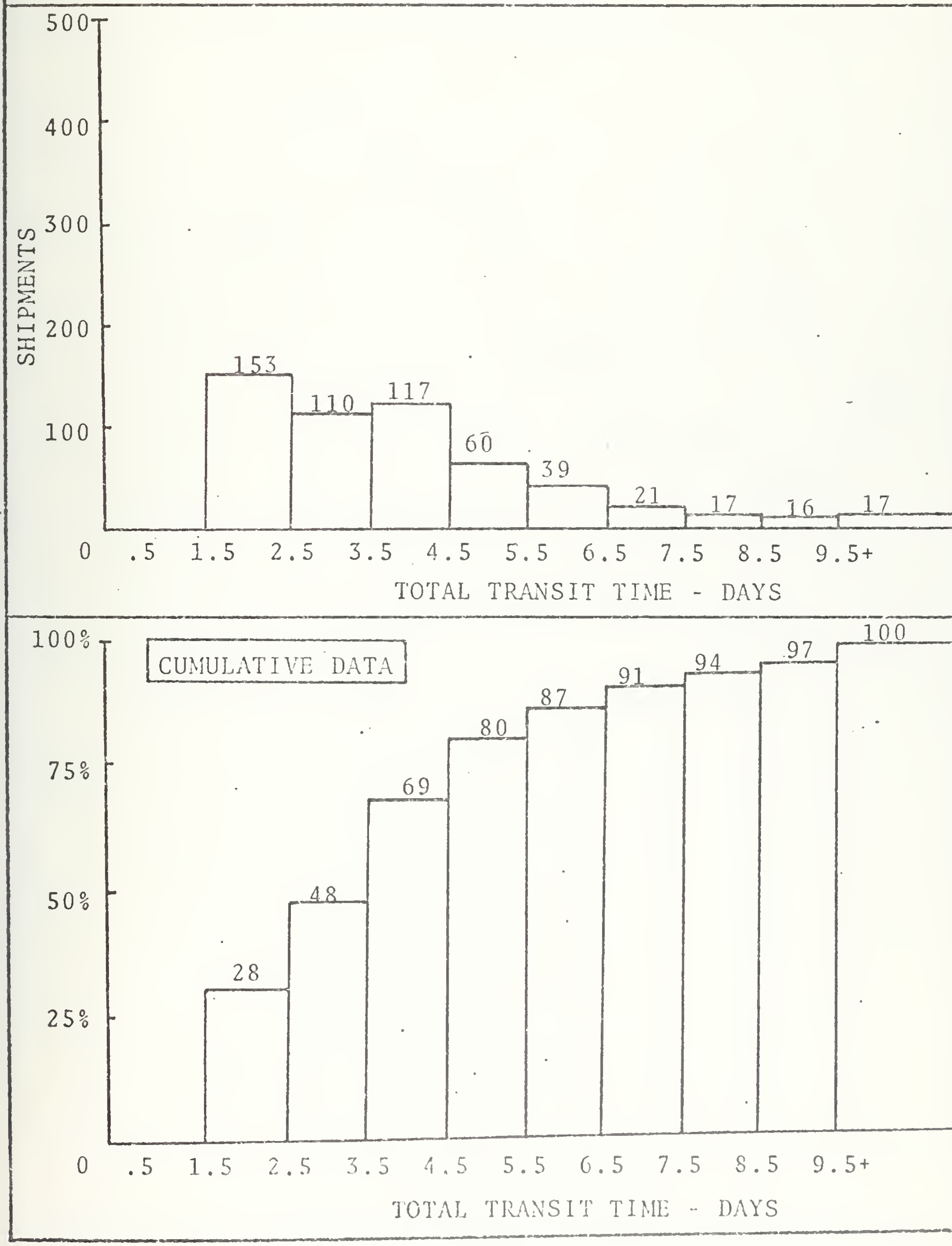


FIGURE 21

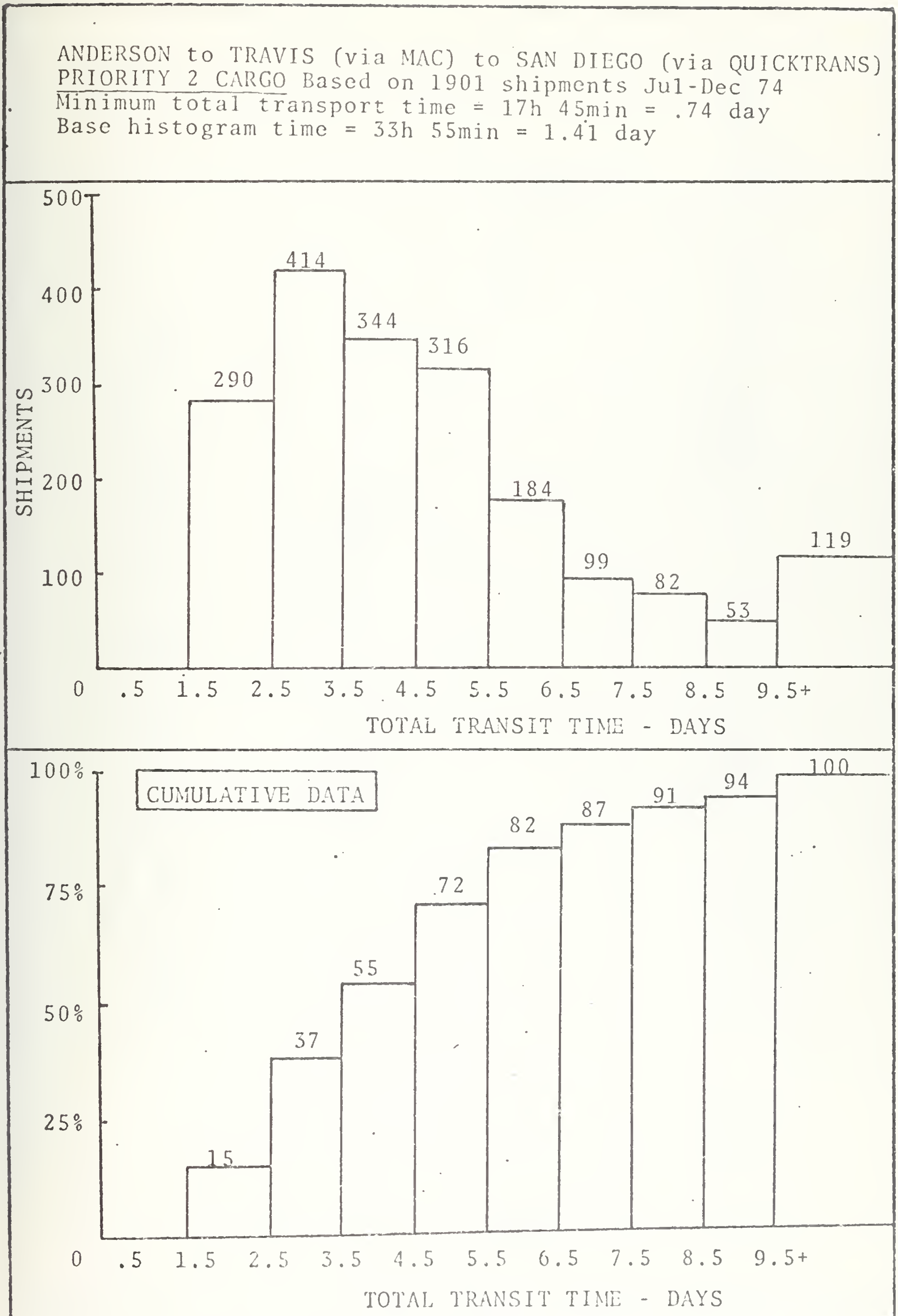

ANDERSON to TRAVIS (via MAC) to SAN DIEGO (via QUICKTRANS)
PRIORITY 2 CARGO Based on 1901 shipments Jul-Dec 74
Minimum total transport time = 17h 45min = .74 day
Base histogram time = 33h 55min = 1.41 day
SHIPMENTS
500
400
300
200
100
0
414
344
316
290
184
99
82
53
119
.5
1.5
2.5
3.5
4.5
5.5
6.5
7.5
8.5
9.5+
TOTAL TRANSIT TIME - DAYS
CUMULATIVE DATA
100%
75%
50%
25%
0
15
37
55
72
82
87
91
94
100
.5
1.5
2.5
3.5
4.5
5.5
6.5
7.5
8.5
9.5+
TOTAL TRANSIT TIME - DAYS

FIGURE 22

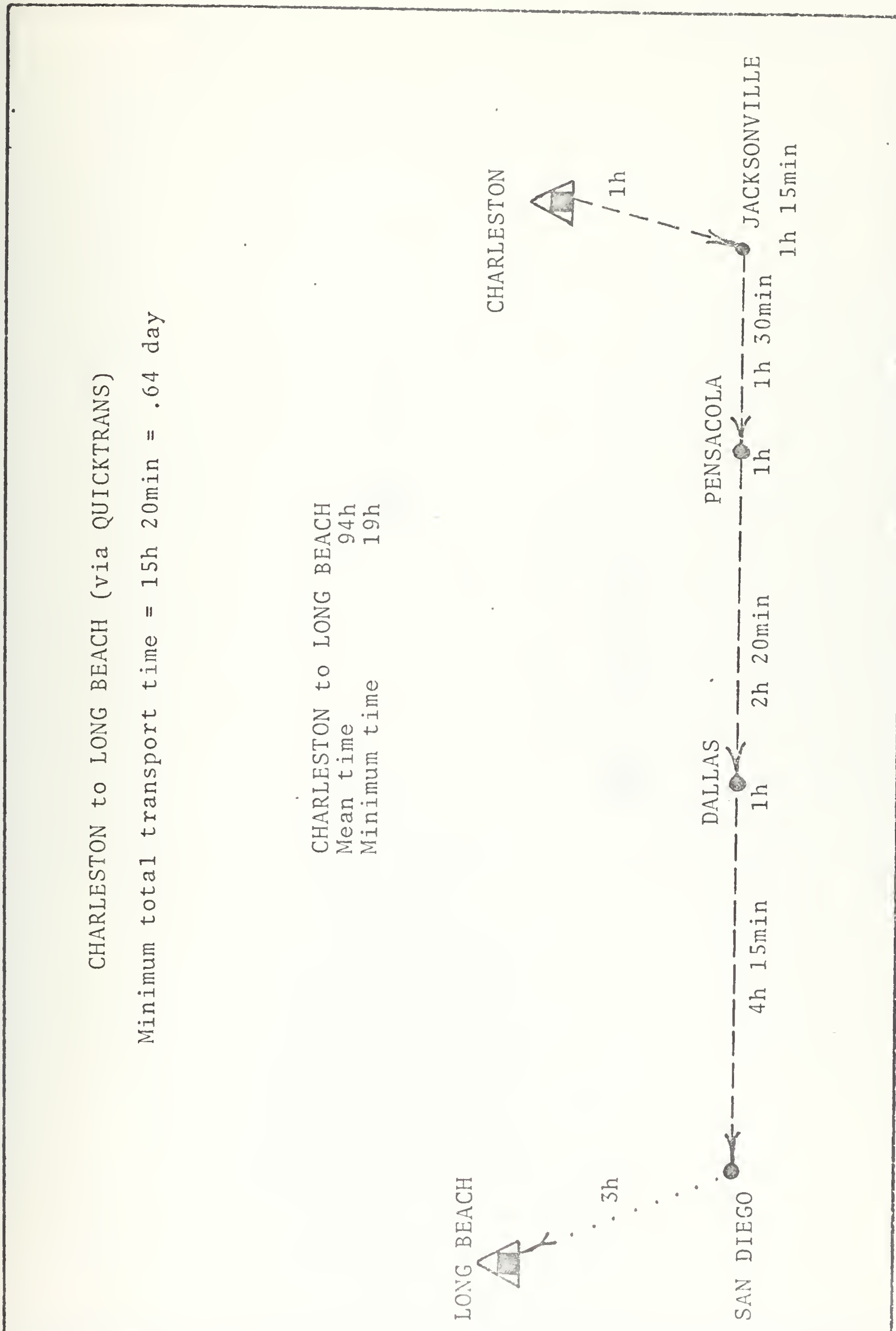

CHARLESTON to LONG BEACH (via QUICKTRANS)
Minimum total transport time = 15h 20min = .64 day
CHARLESTON to LONG BEACH
Mean time 94h
Minimum time 19h
CHARLESTON
1h
JACKSONVILLE
1h 15min
1h 30min
PENSACOLA
1h
2h 20min
DALLAS
1h
4h 15min
SAN DIEGO
3h
LONG BEACH

FIGURE 23

CHARLESTON TO NORFOLK (via QUICKTRANS)

Minimum total transport time = 1h 20min = .05 day

CHARLESTON TO NORFOLK	
Mean time	25h
Minimum time	7h

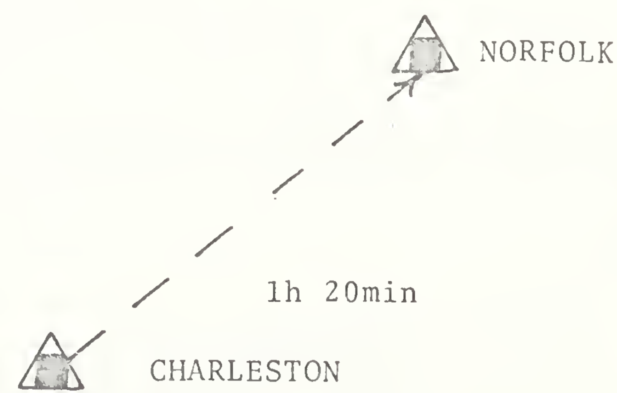


FIGURE 24

CLARK to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS

Minimum total transport time = 23h (C-141) + 1h 50min + 3h = 27h 50min = 1.16 day

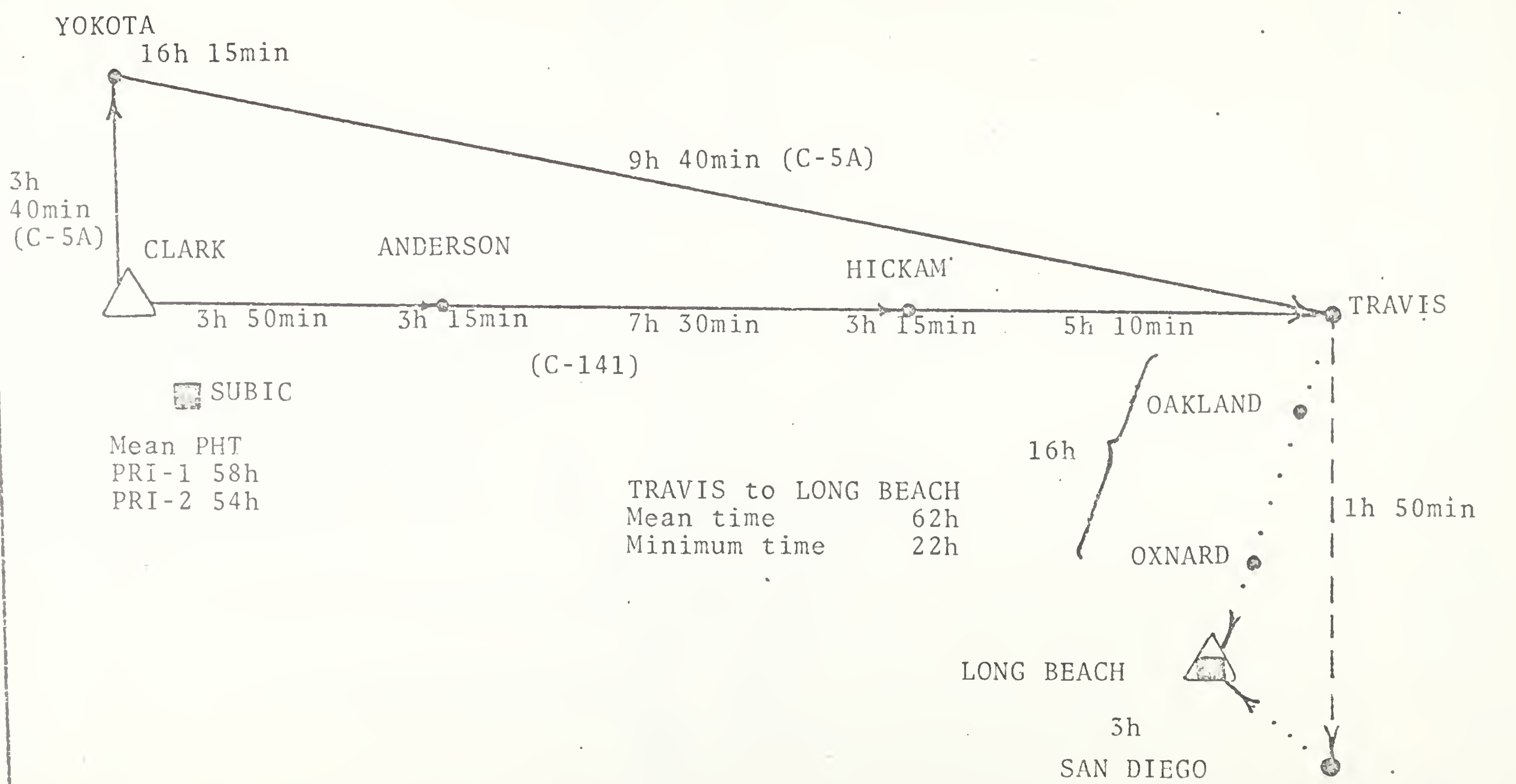


FIGURE 25

CLARK to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS)
PRIORITY 1 CARGO Based on 397 shipments Jul-Dec 74
Minimum total transport time = 27h 50min = 1.16 day
Base histogram time = 85h = 3.54 day

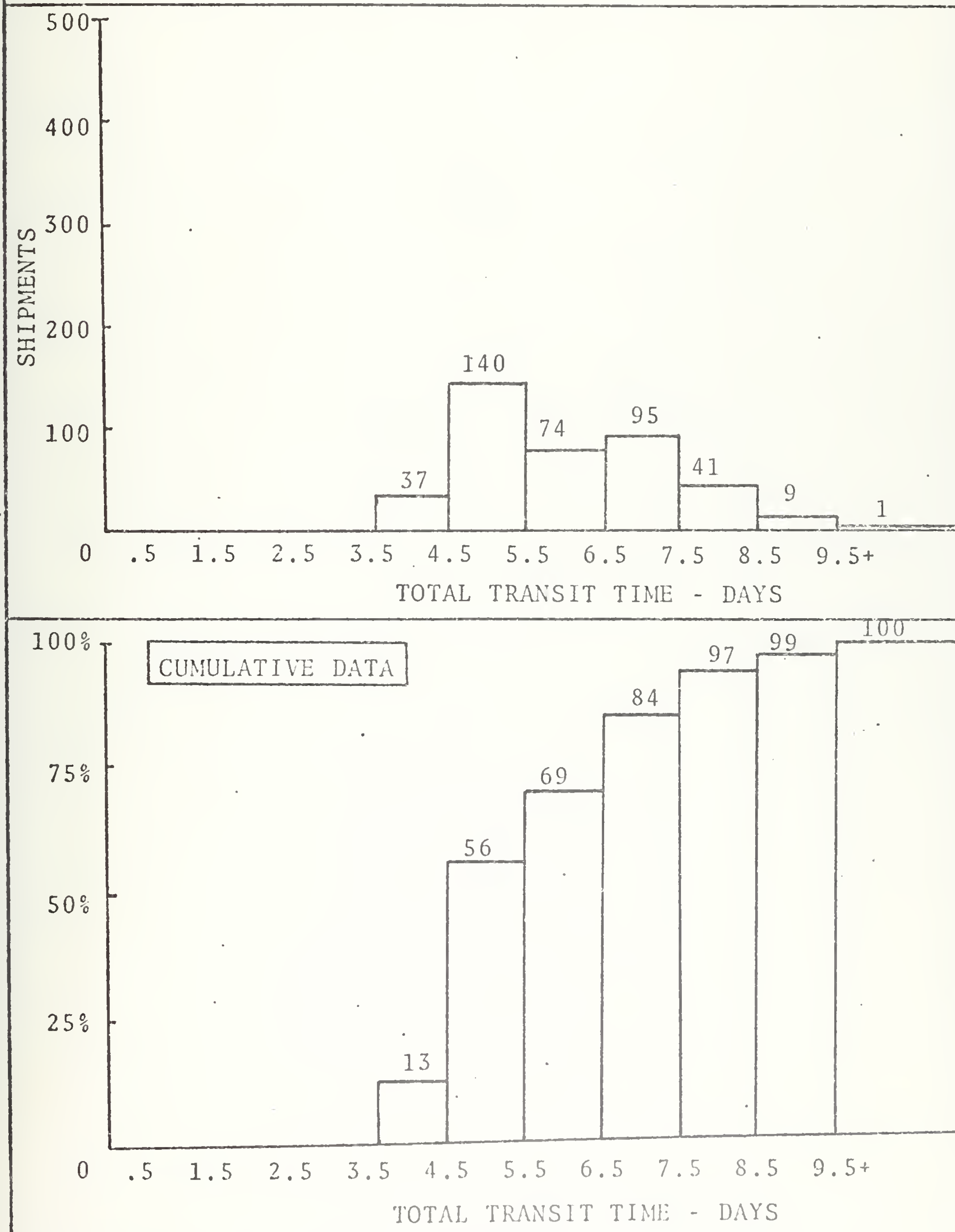


FIGURE 26

CLARK to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS)
PRIORITY 2 CARGO Based on 397 shipments Jul-Dec 74
Minimum total transport time = 27h 50min = 1.16 day
Base histogram time = 85h = 3.54 day

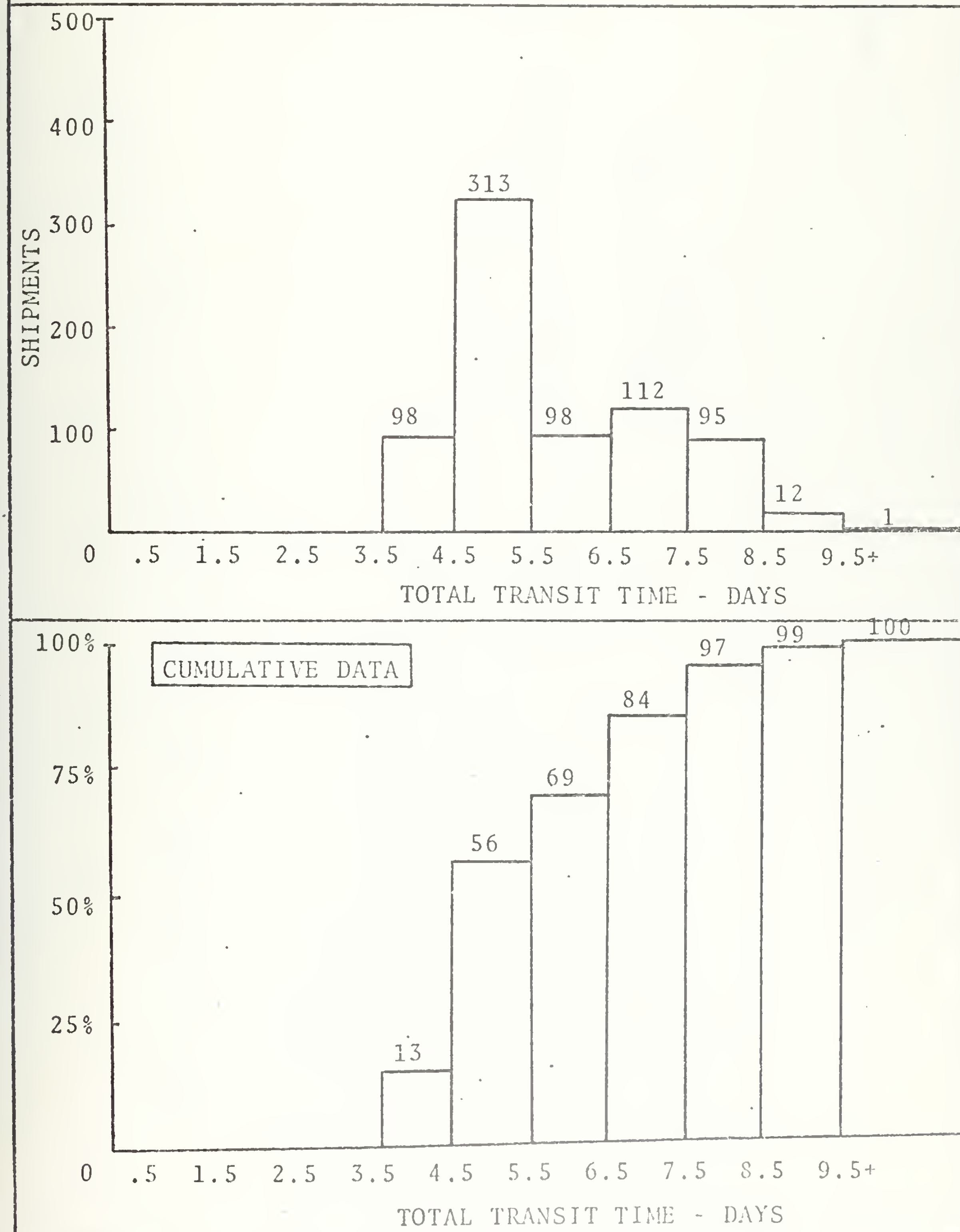


FIGURE 27

CLARK to TRAVIS (vis MAC) to SAN DIEGO (via QUICKTRANS)

Minimum total transport time = 23h (C-141) + 1h 50min = 24h 50min = 1.03 day
Base histogram time = 23h (C-141) + 18h = 41h = 1.7 day
(PRI-3 and 999 data samples insufficient)

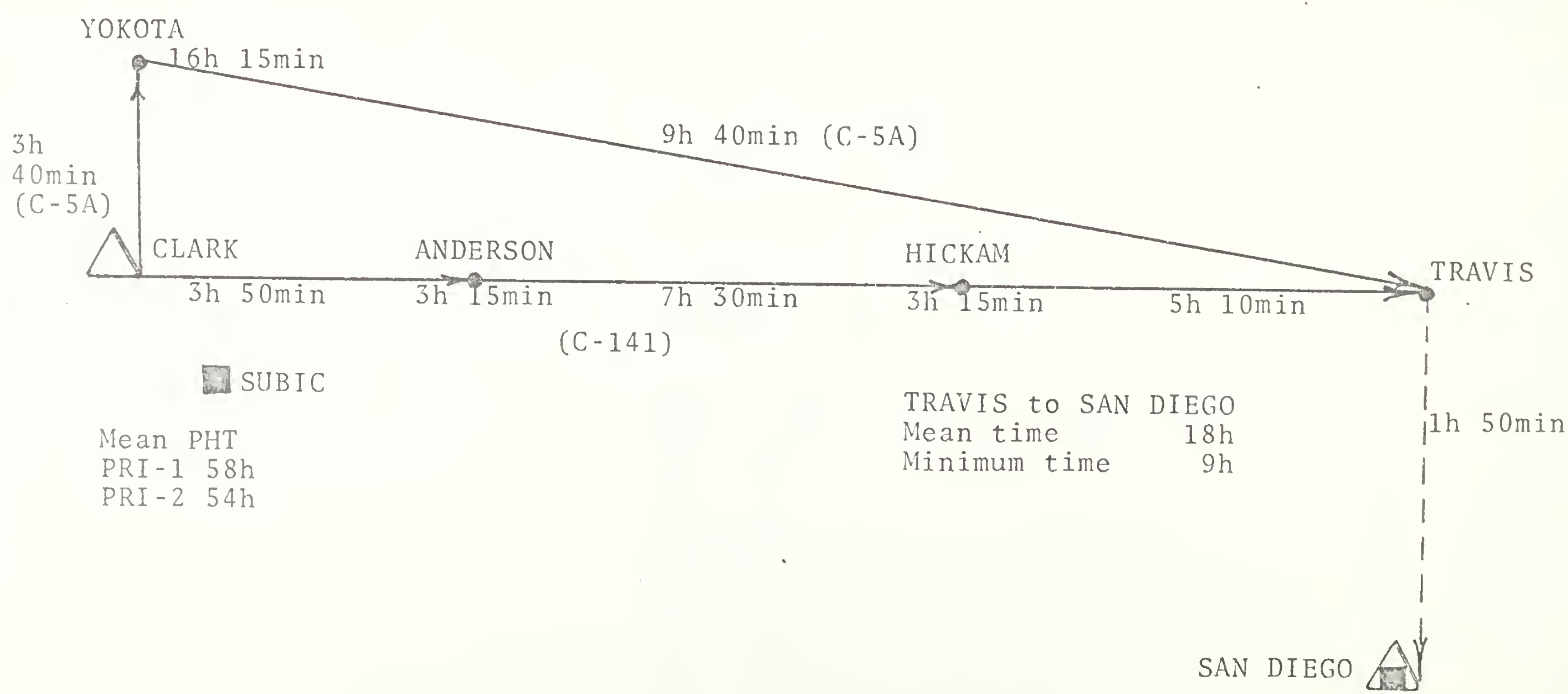
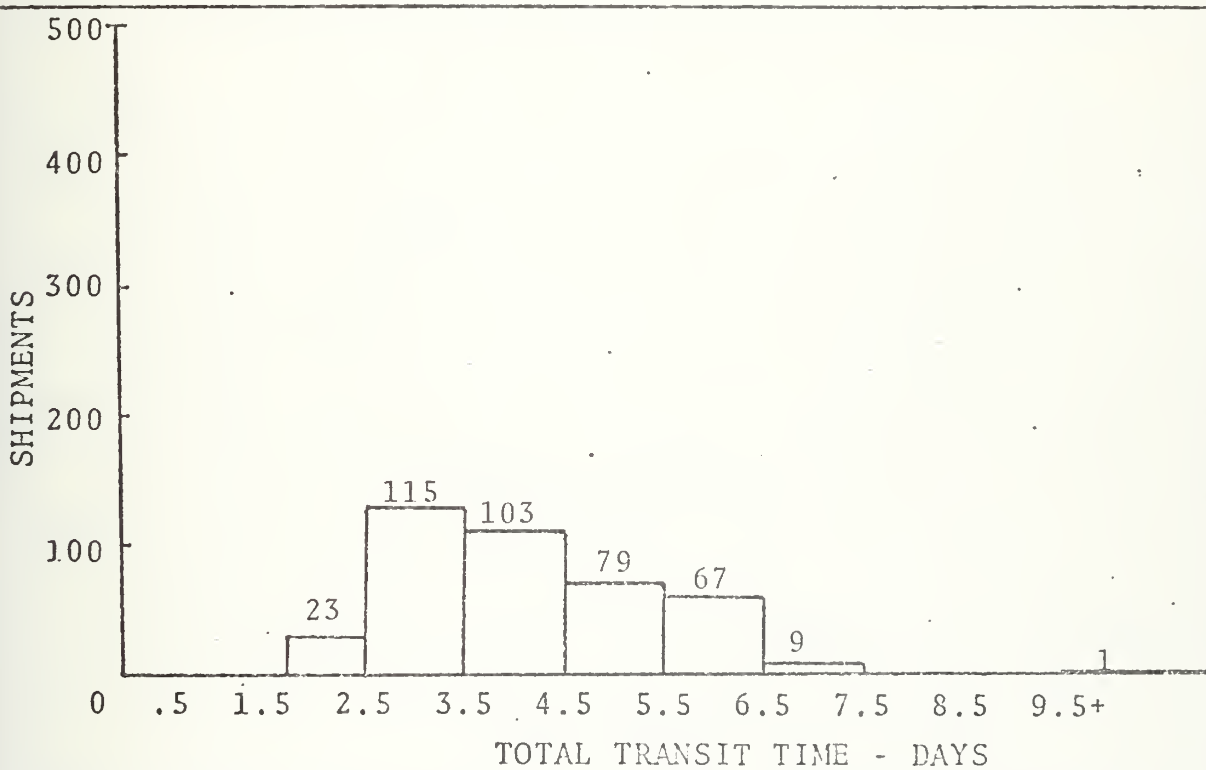


FIGURE 28

CLARK to TRAVIS (via MAC) to SAN DIEGO (via QUICKTRANS)
PRIORITY 1 CARGO Based on 397 shipments Jul-Dec 74
Minimum total transport time = 23h 50min = 1.03 day
Base histograms time = 41h = 1.7 day



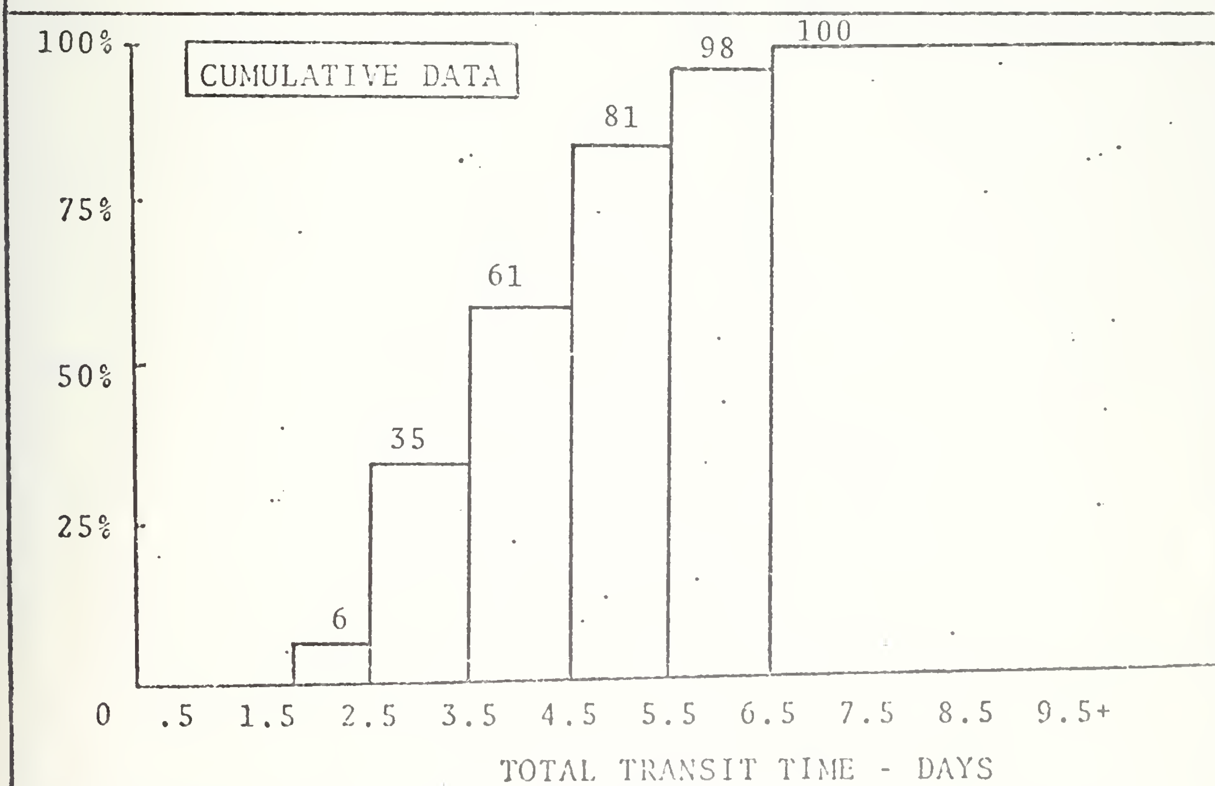
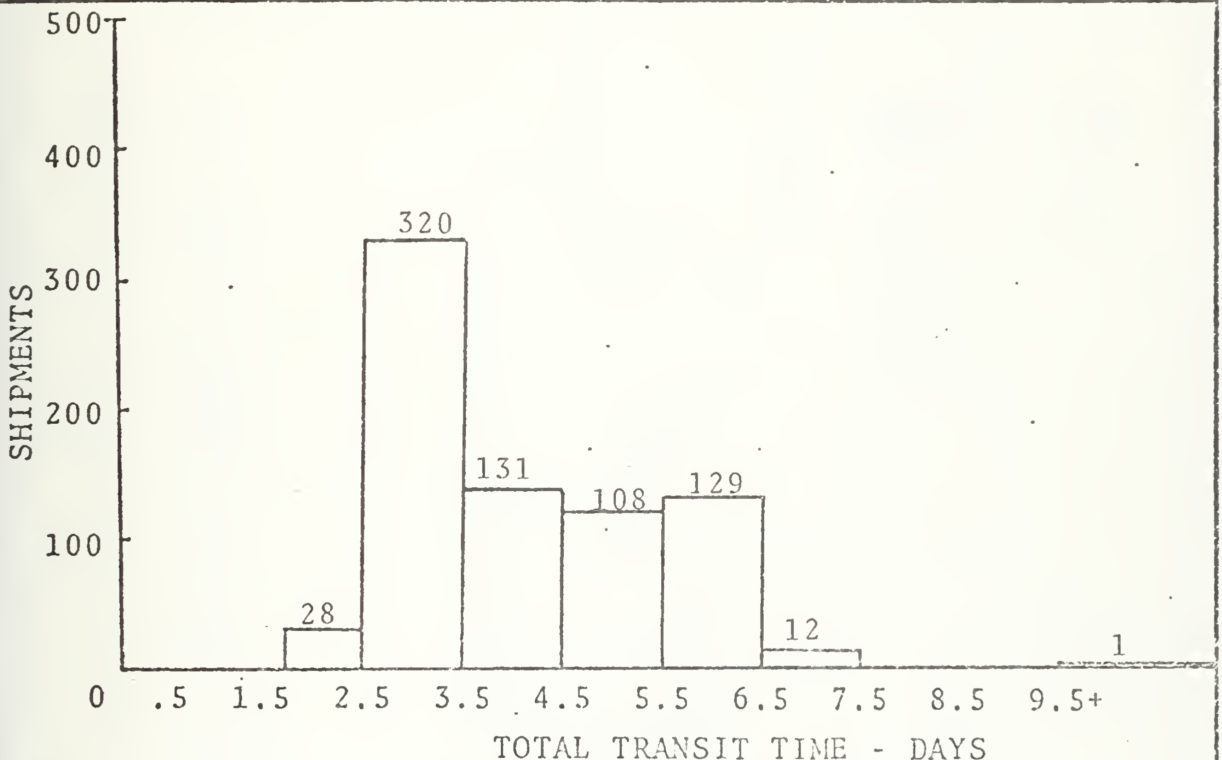


FIGURE 29

CLARK to TRAVIS (via MAC) to SAN DIEGO (via QUICKTRANS)
PRIORITY 2 CARGO Based on 397 shipments Jul-Dec 74
Minimum total transport time = 24h 50min = 1.03 day
Base histogram time = 41h = 1.7 day



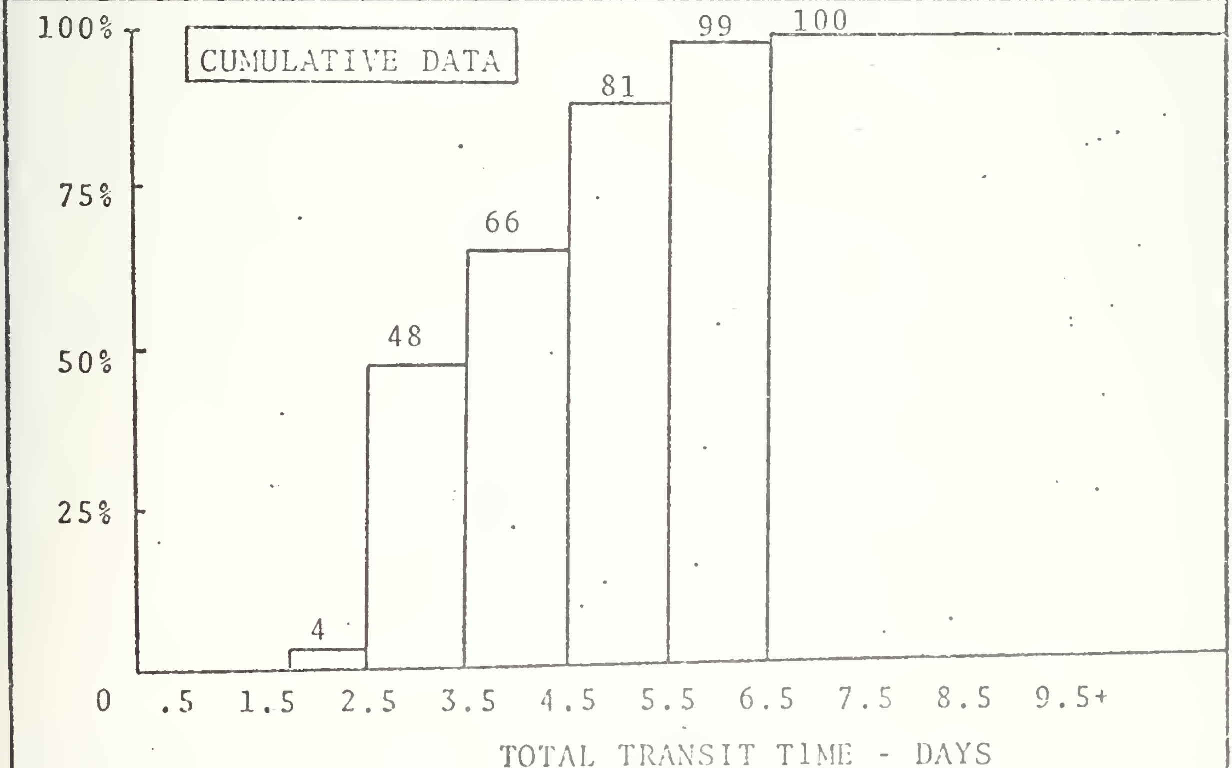


FIGURE 30

HICKAM to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS)

Minimum total transport time = 5h 10min + 1h 50min + 3h = 10h = .42 day
Base histogram time = 5h 10min +62h = 67h 10min = 2.8 day
(PRI-3 data sample insufficient)

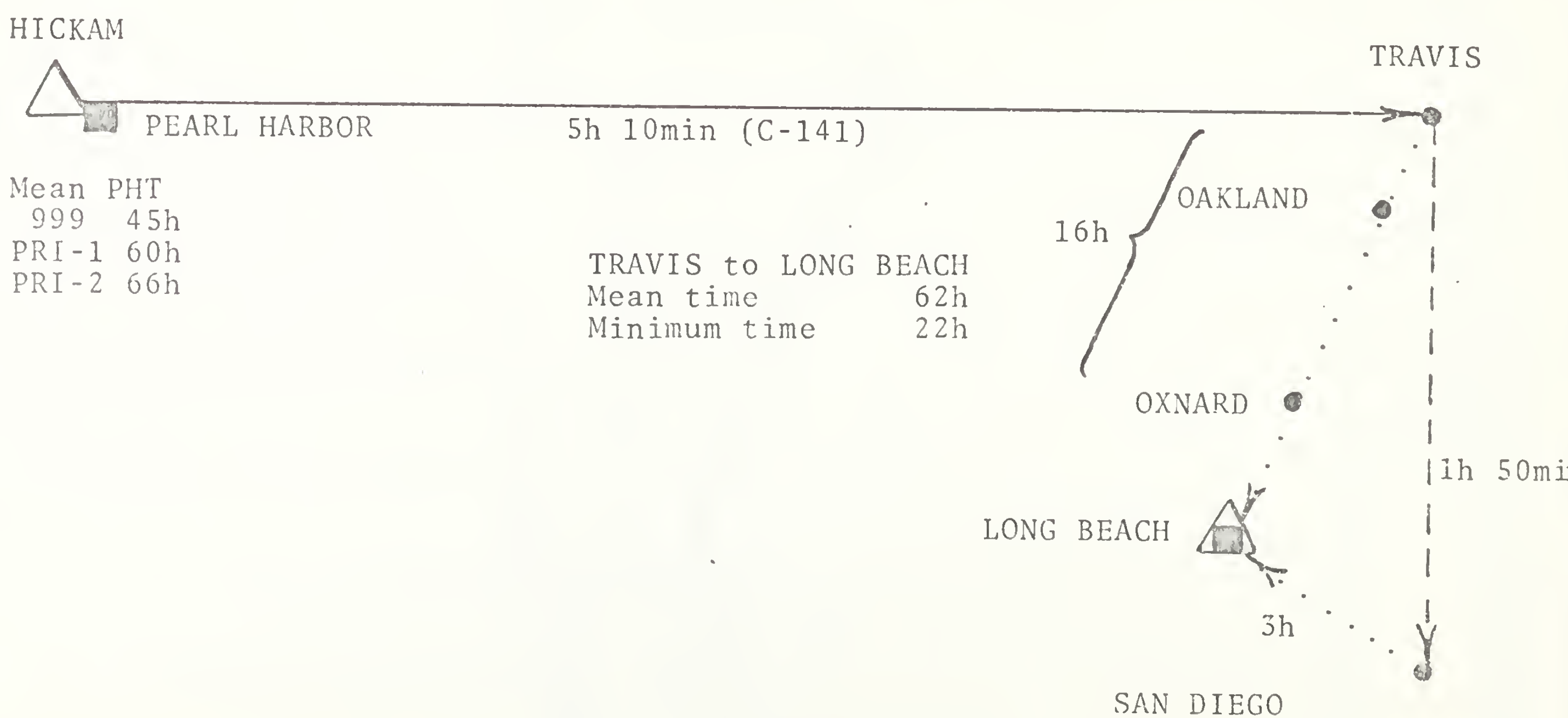


FIGURE 31

HICKAM to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS)
999 CARGO Based on 439 shipments Jul-Dec 74
Minimum total transport = 10h = .42 day
Base histogram time = 67h 10min = 2.8 day

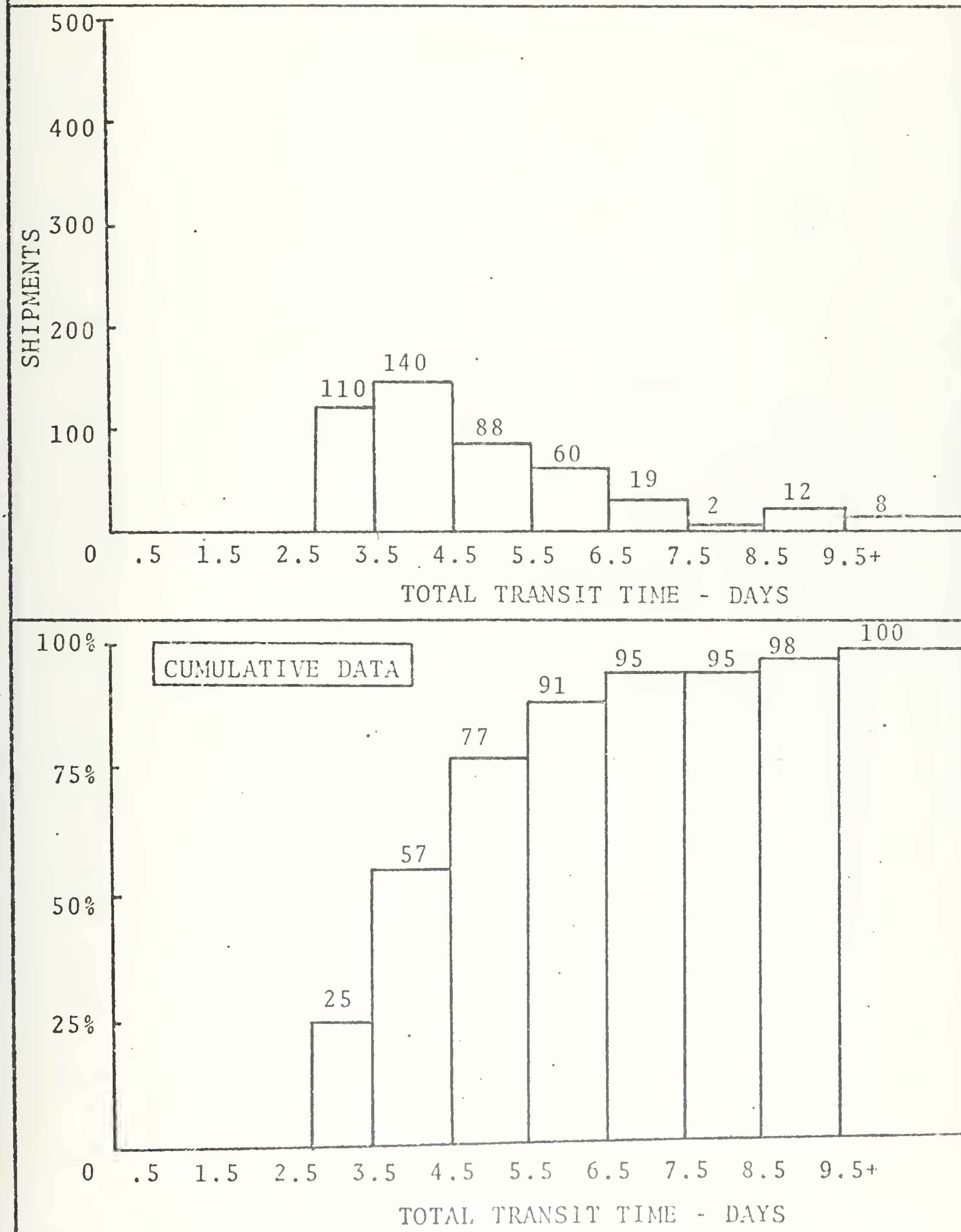


FIGURE 32

HICKAM to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS)
PRIORITY 1 CARGO Based on 1550 shipments Jul-Dec 74
Minimum total transport time = 10h = .42 day
Base histogram time = 67h 10min = 2.8 day

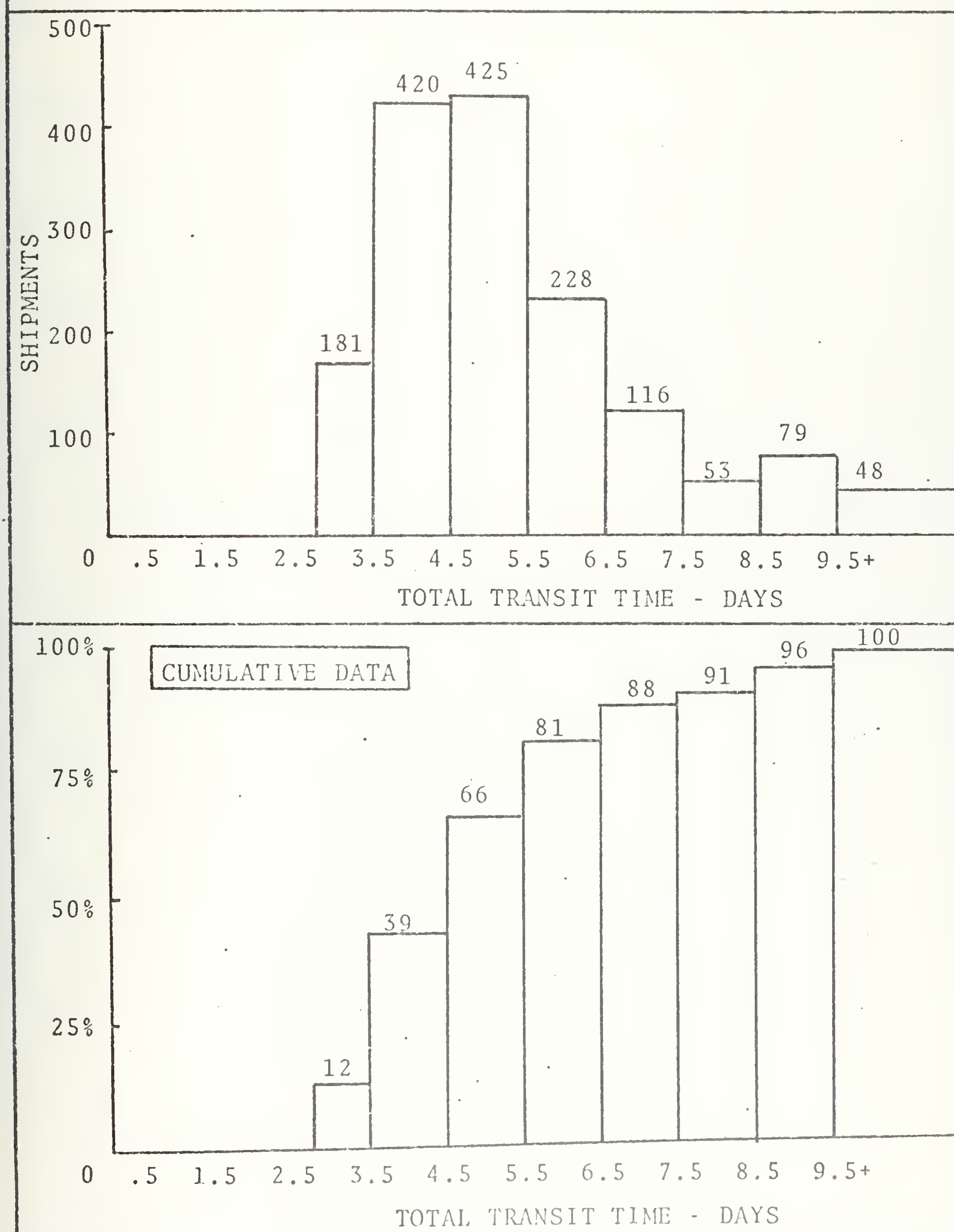
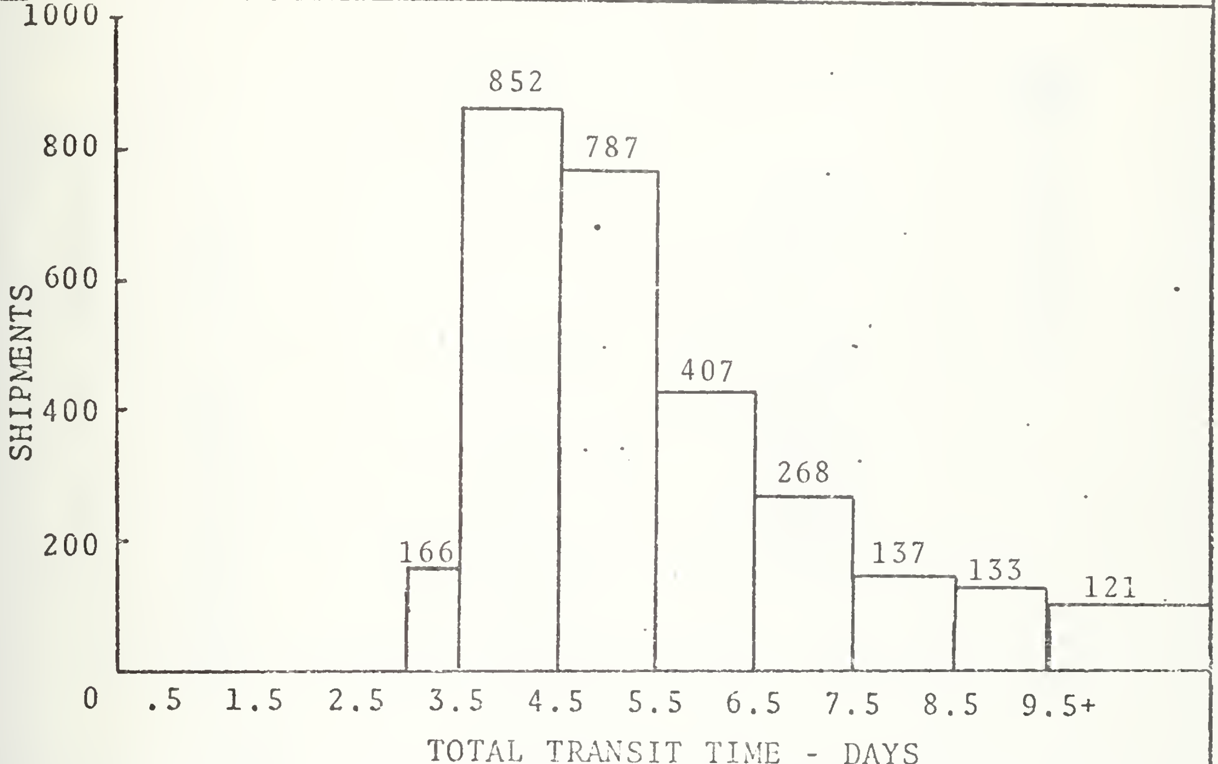


FIGURE 33

HICKAM to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS)
PRIORITY 2 CARGO Based on 2871 shipments Jul-Dec 74
Minimum total transport time = 10h = .42 day
Base histogram time = 67h 10min = 2.8 day



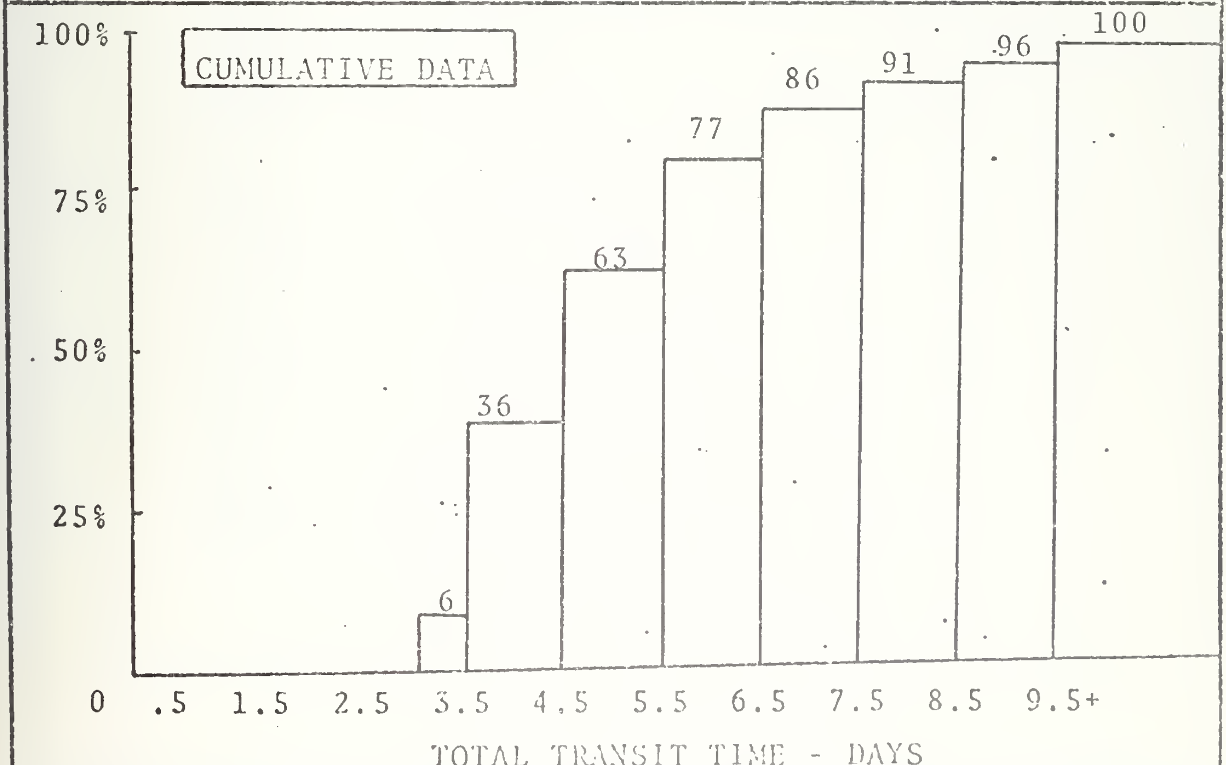


FIGURE 34

HICKAM to TRAVIS (via MAC) to SAN DIEGO (via QUICKTRANS)

Minimum total transport time = 5h 10min + 1h 50min = 7h = .29 day
Base histogram time = 5h 10min + 18h = 23h 10min = .97 day
(PRI-3 data sample insufficient)

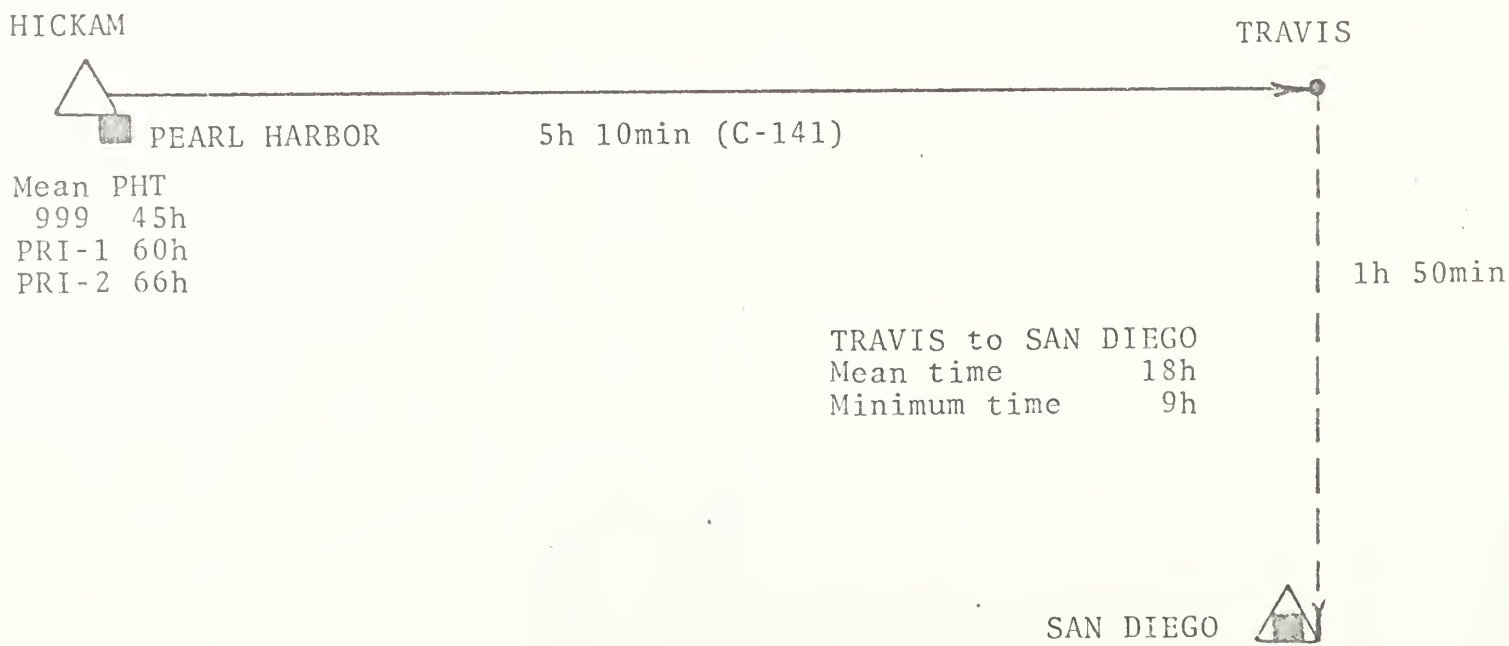


FIGURE 35

HICKAM to TRAVIS (via MAC) to SAN DIEGO (via QUICKTRANS)
999 CARGO Based on 439 shipments Jul-Dec 74
Minimum total transport time = 7h = .29 day
Base histogram time = 23h 10min = .97 day

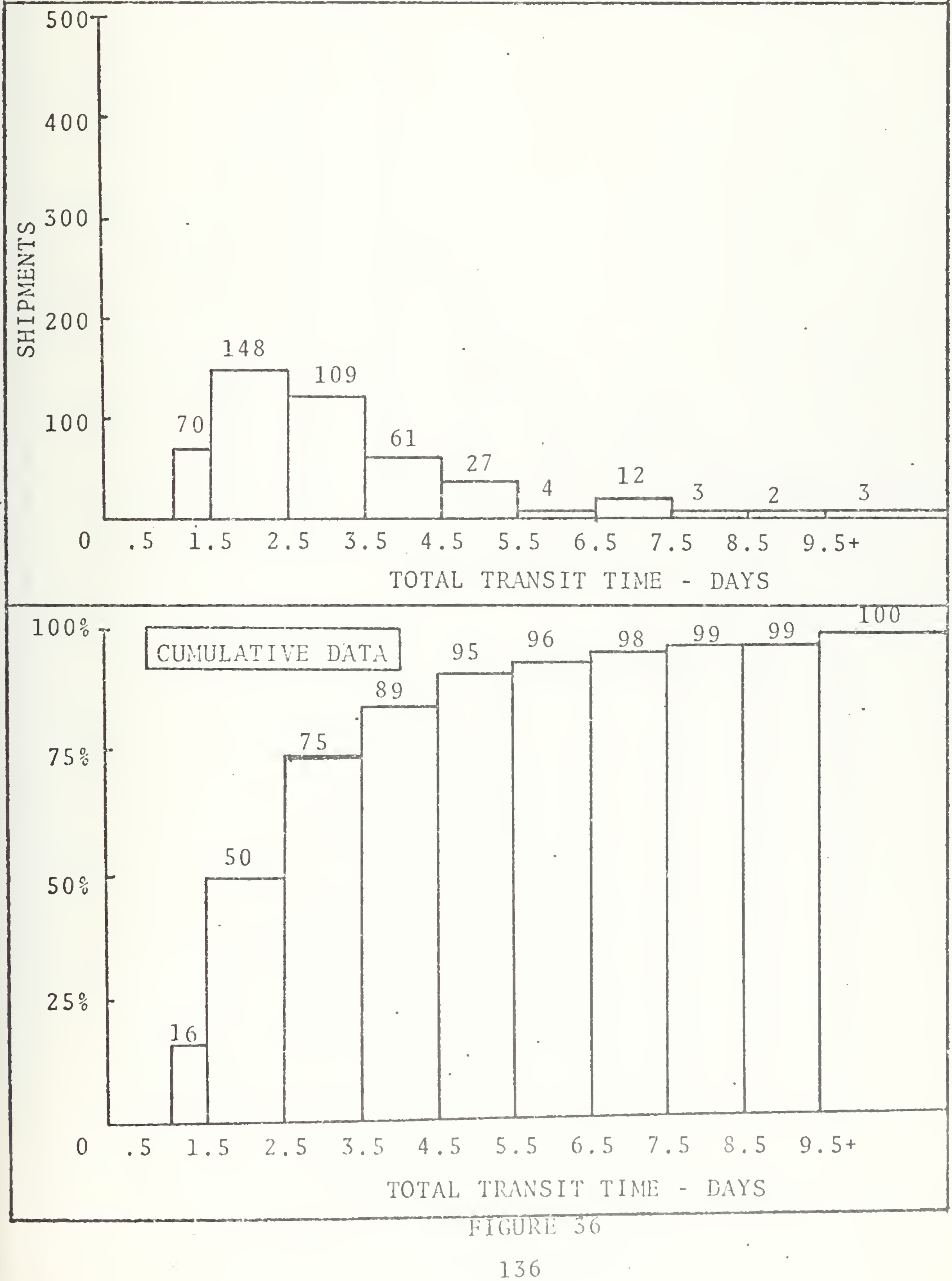
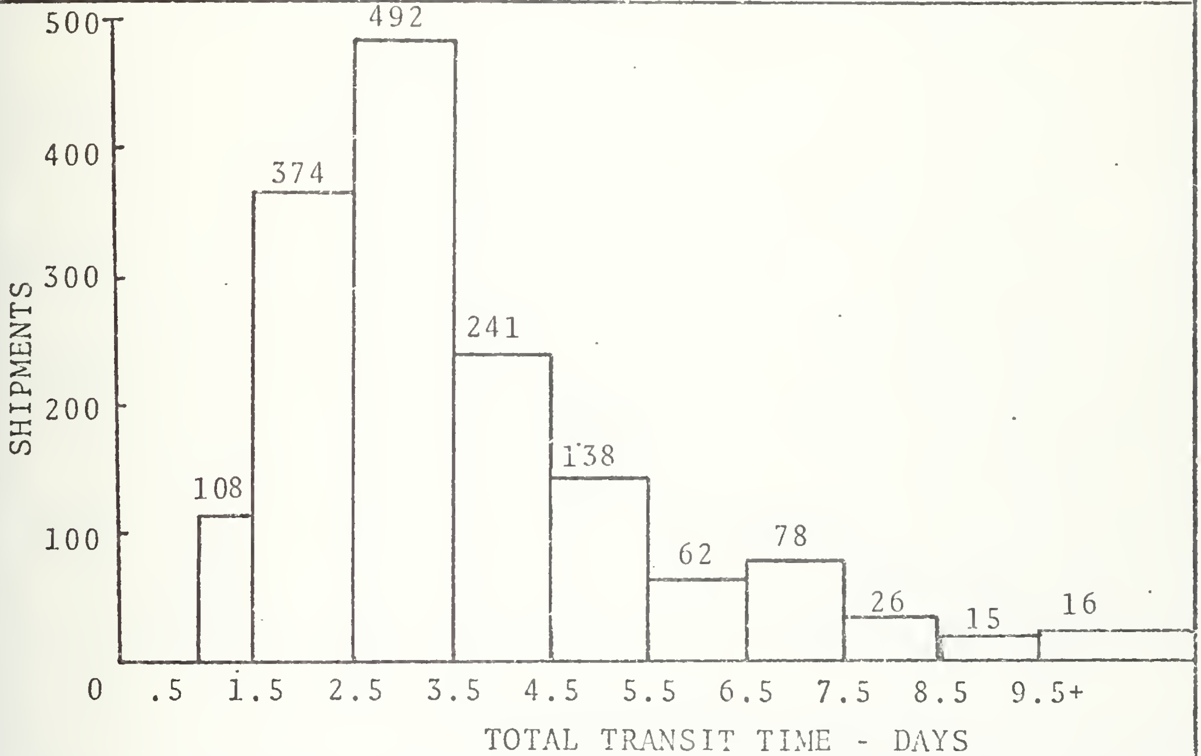


FIGURE 36

HICKAM to TRAVIS (via MAC) to SAN DIEGO (via QUICKTRANS)
PRIORITY 1 CARGO Based on 1550 shipments Jul-Dec 74
Minimum total transport time = 7h = .29 day
Base histogram time = 23h 10min = .97 day



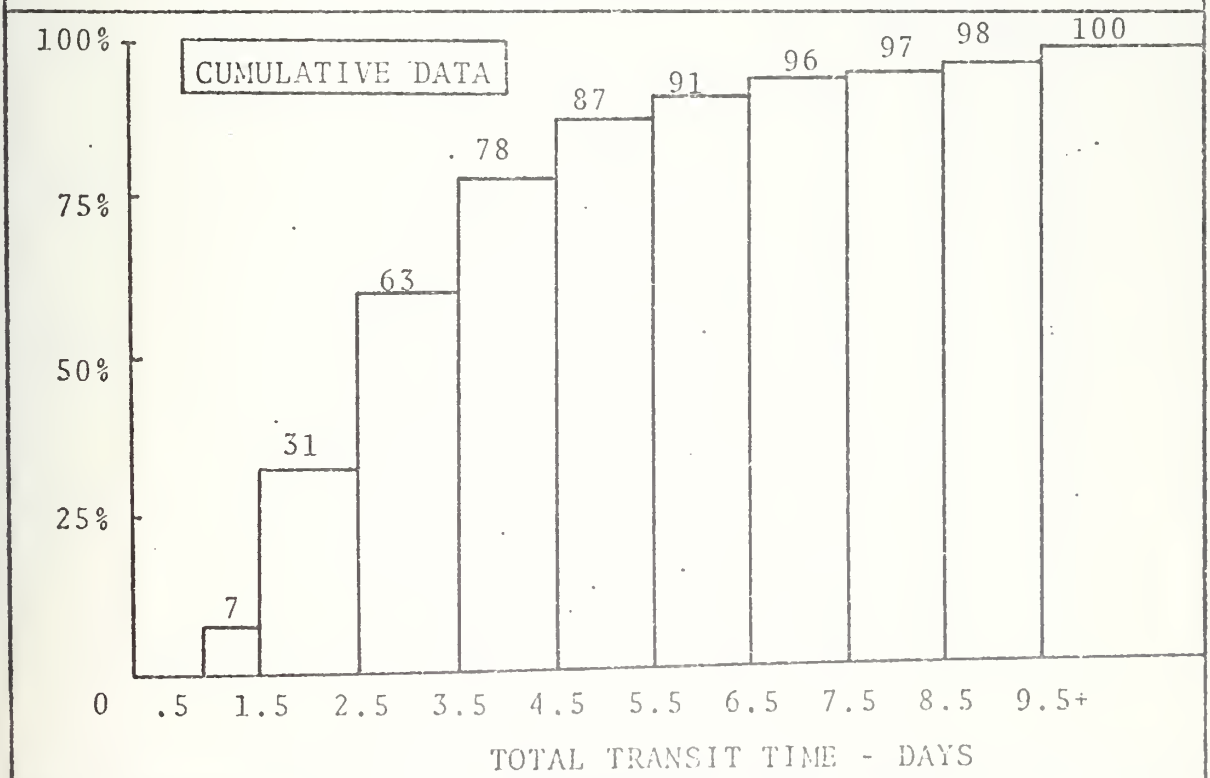
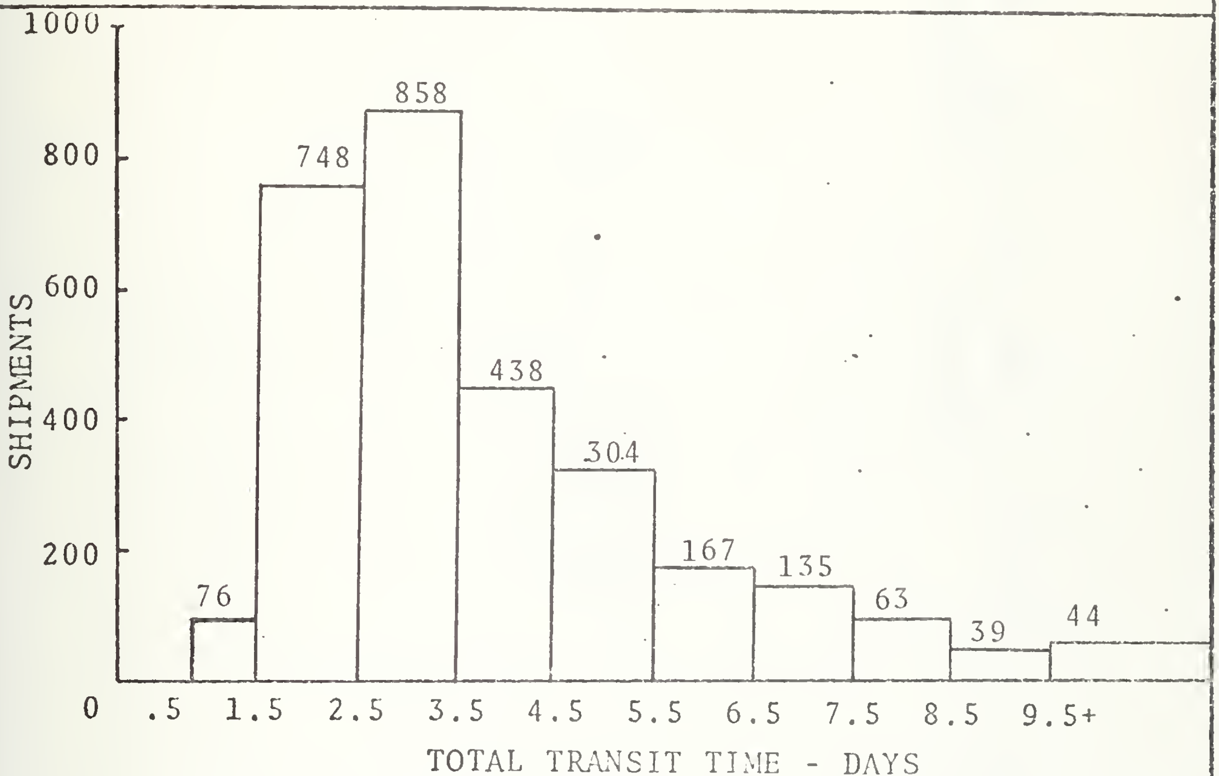


FIGURE 37

HICKAM to TRAVIS (via MAC) to SAN DIEGO (via QUICKTRANS)
PRIORITY 2 CARGO Based on 2822 shipments Jul-Dec 74
Minimum total transport time = 7h = .29 day
Base histogram time = 23h 10min = .97 day



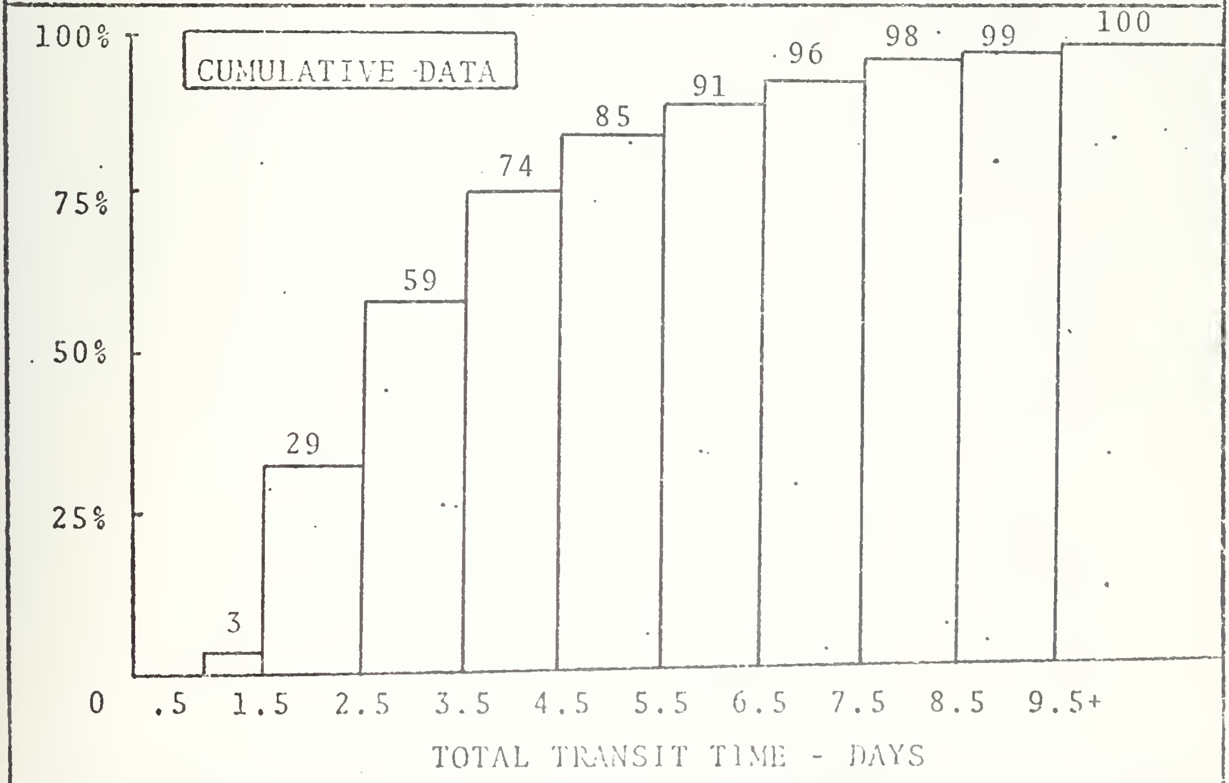


FIGURE 38

JACKSONVILLE to LONG BEACH (via QUICKTRANS)

Minimum total transport time = 13h 5min = .55day

JACKSONVILLE to LONG BEACH	
Mean time	79h
Minimum time	18h

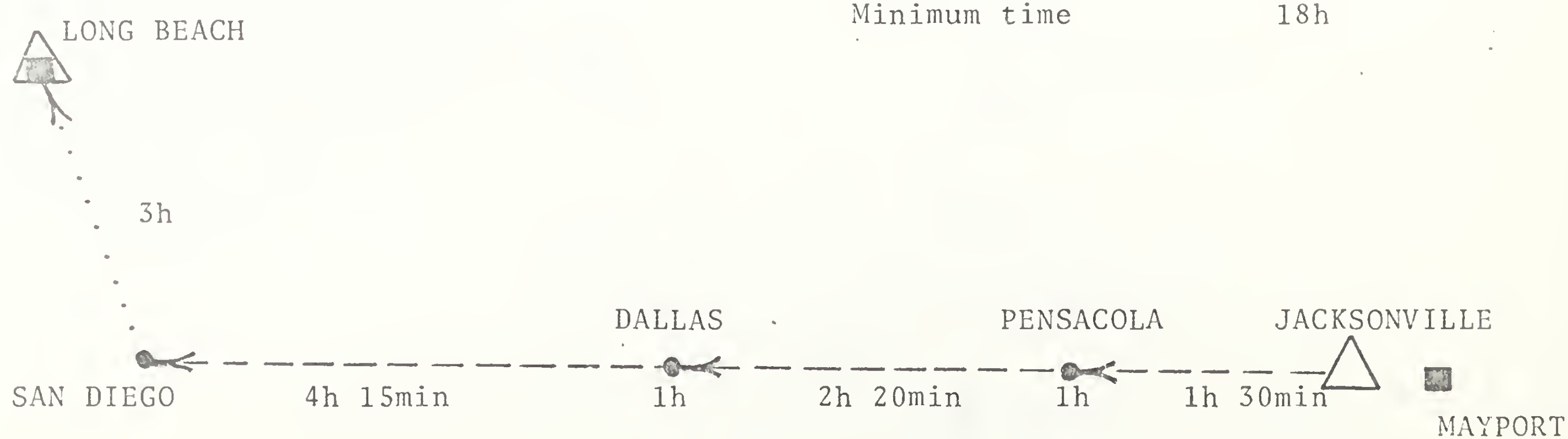
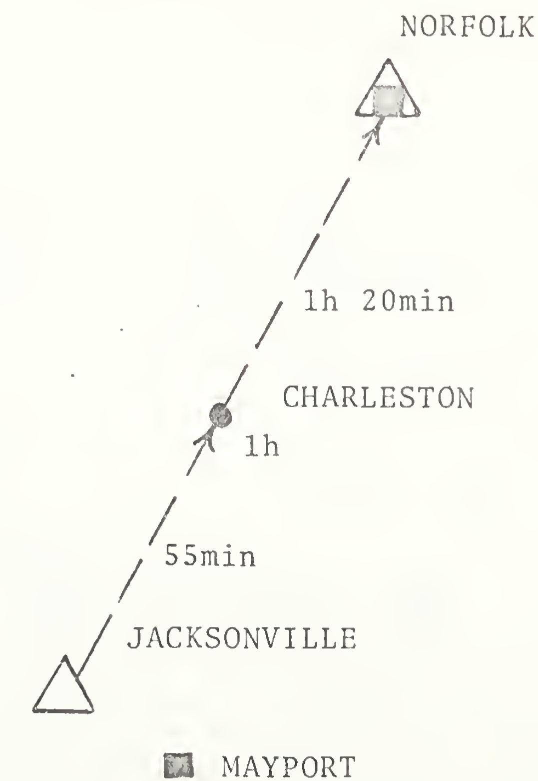


FIGURE 39

JACKSONVILLE to NORFOLK (via QUICKTRANS)

Minimum total transport time = 3h 15min = .14 day



JACKSONVILLE to NORFOLK	
Mean time	56h
Minimum time	9h

FIGURE 40

LONG BEACH to TRAVIS (via QUICKTRANS) to ANDERSON (via MAC)

Minimum total transport time = 3h + 1h 55min + 18h (C-141) = 22h 55min = .95 day
Base histogram time = 35h + 18h (C-141) = 53h = 2.2 day
(PRI-3 data sample insufficient)

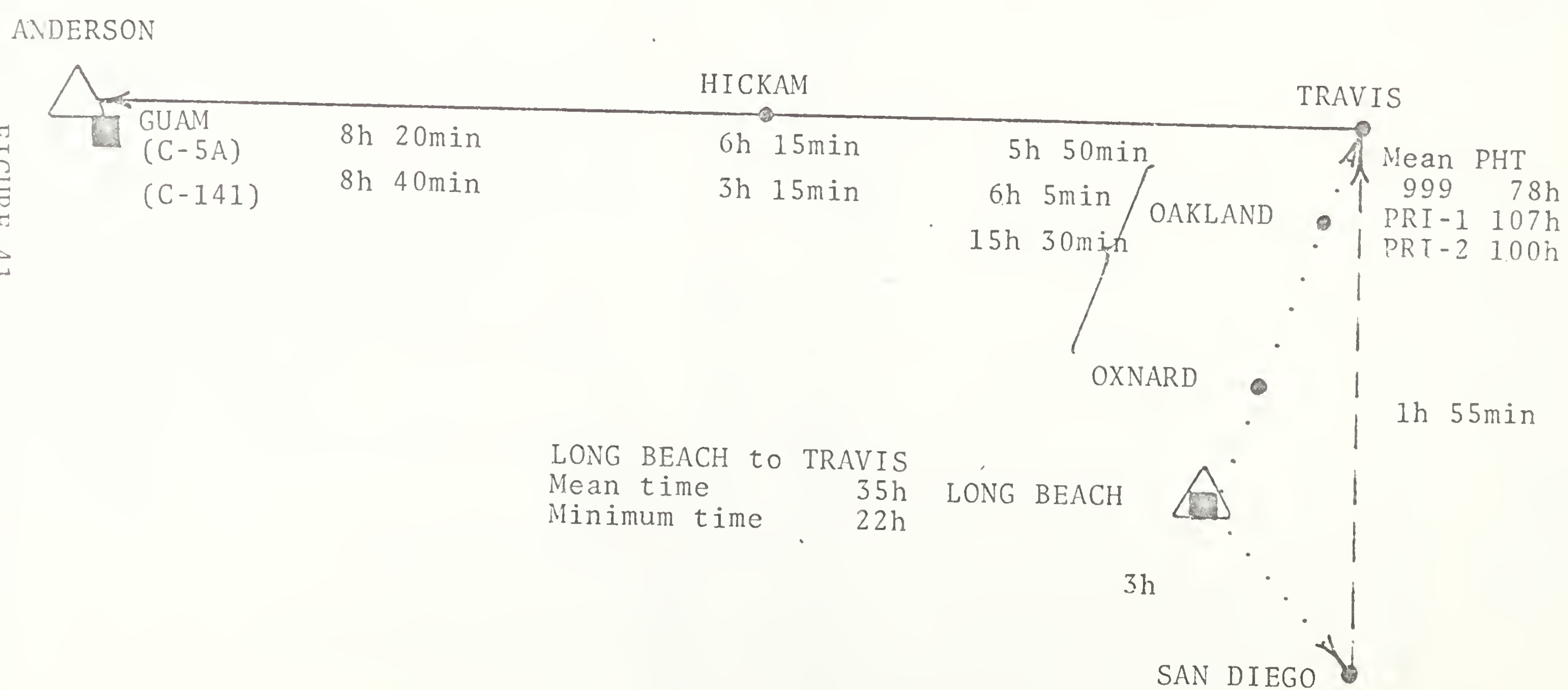


FIGURE 41

LONG BEACH to TRAVIS (via QUICKTRANS) to ANDERSON (via MAC)
999 CARGO Based on 301 shipments Jul-Dec 74
Minimum total transport time = 22h 55min = .95 day
Base histogram time = 53h = 2.2 day

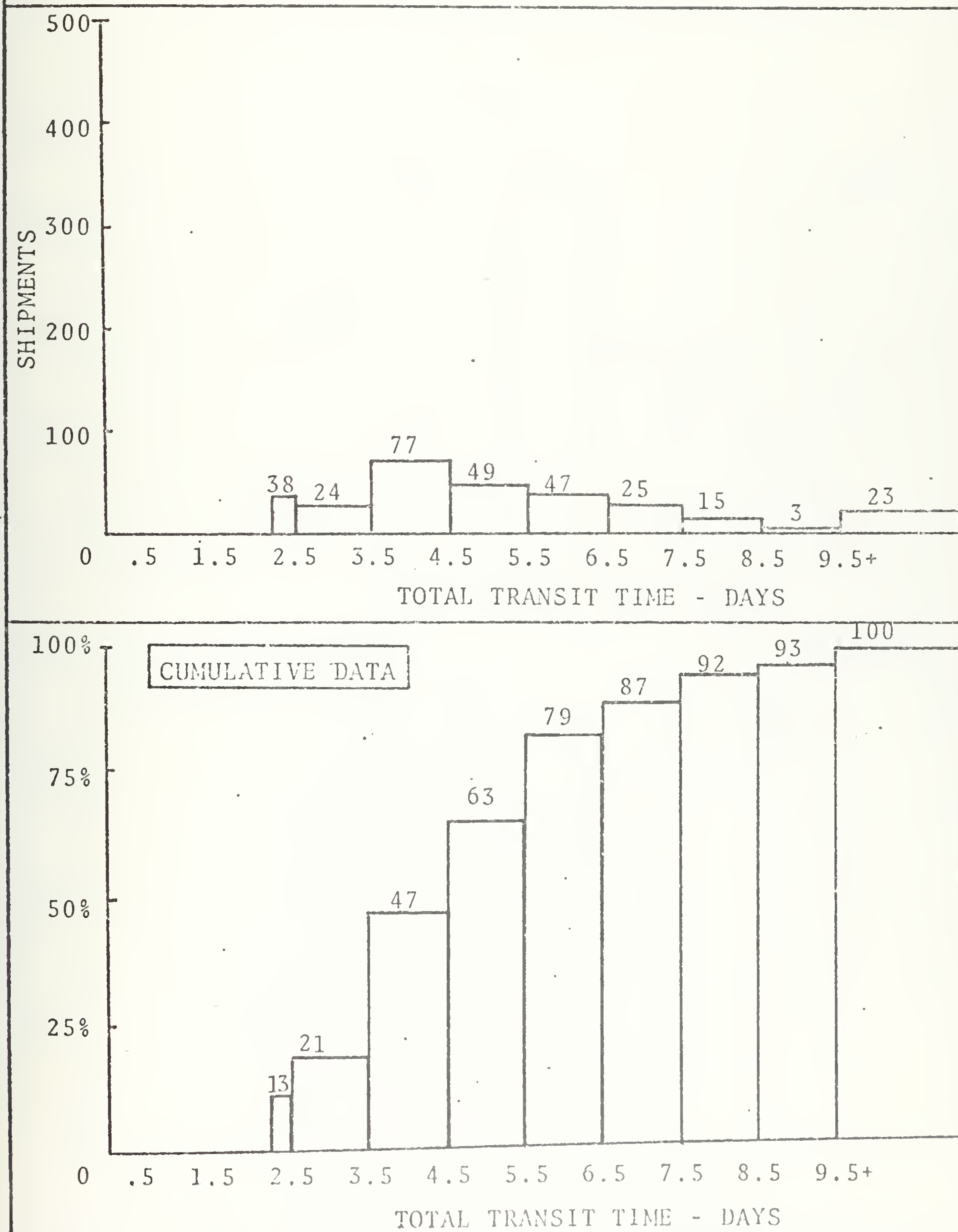
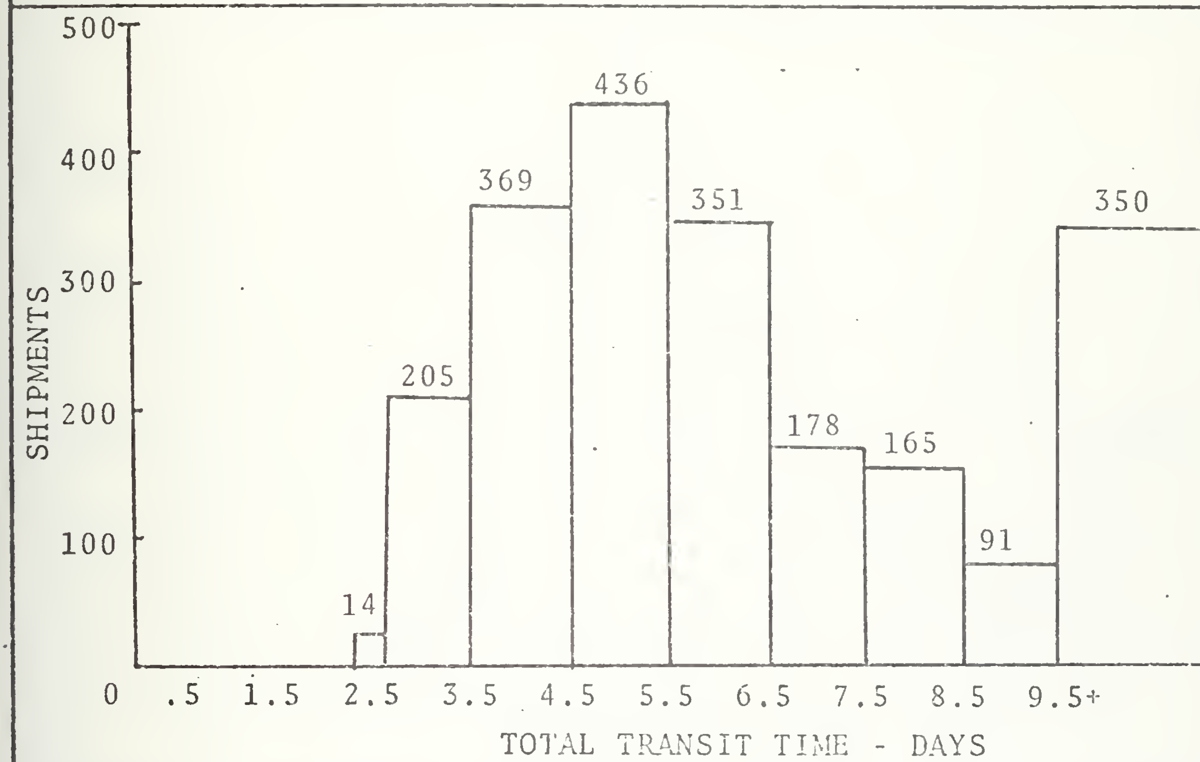


FIGURE 42

LONG BEACH to TRAVIS (via QUICKTRANS) to ANDERSON (via MAC)
PRIORITY 1 CARGO Based on 2159 shipments Jul-Dec 74
Minimum total transport time = 22h 55min = .95 day
Base histogram time = 53h = 2.2 day



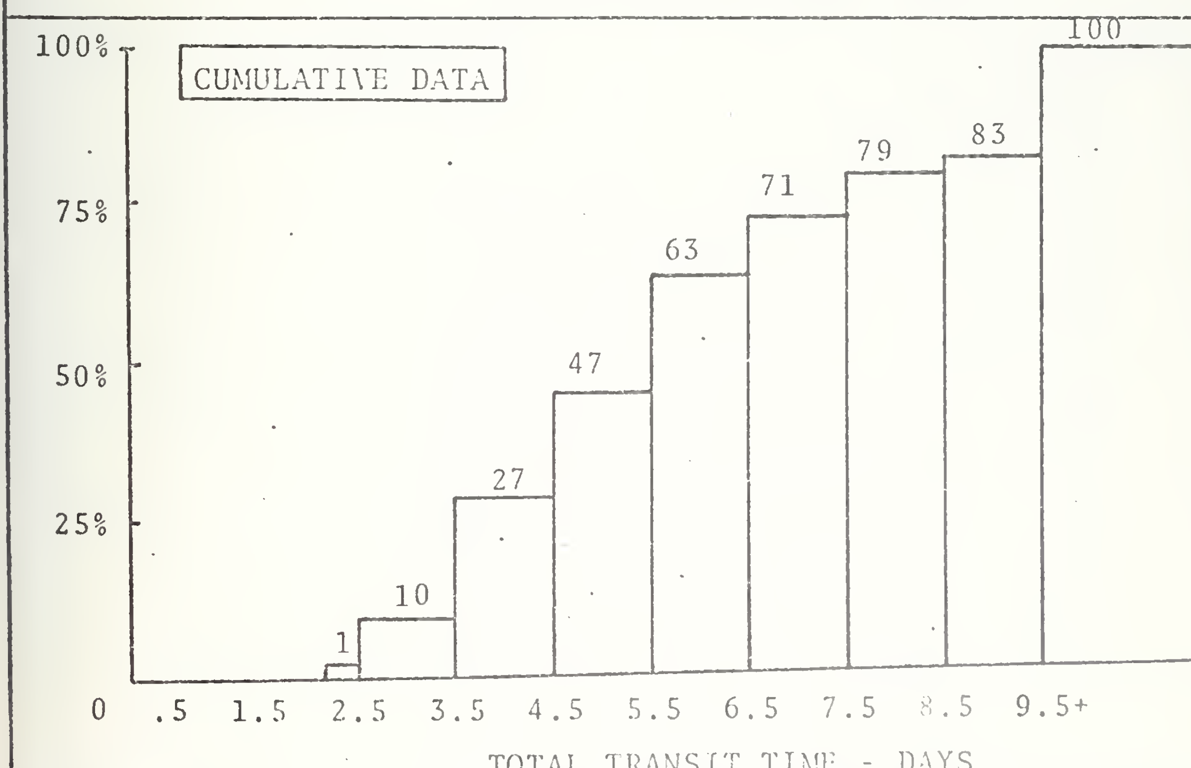


FIGURE 43

LONG BEACH to TRAVIS (via QUICKTRANS) to ANDERSON (via MAC)
PRIORITY 2 CARGO Based on 7078 shipments Jul-Dec
Minimum total transport time = 22h 55min = .95 day
Base histogram time = 53h = 2.2 day

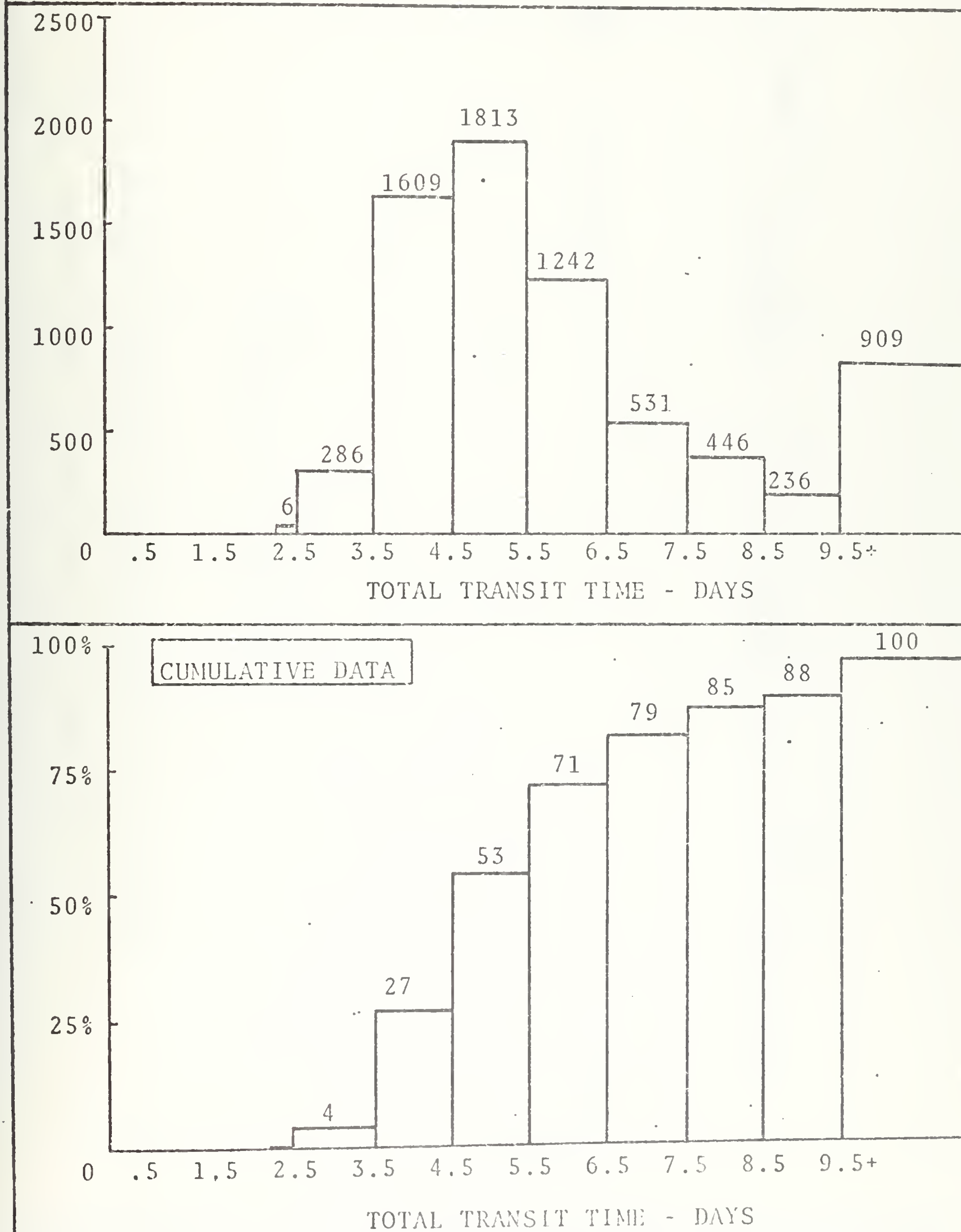


FIGURE 44

LONG BEACH to CHARLESTON (via QUICKTRANS)

Minimum total transport time = 14h 20min = .60 day

LONG BEACH to CHARLESTON	
Mean time	52h
Minimum time	23h

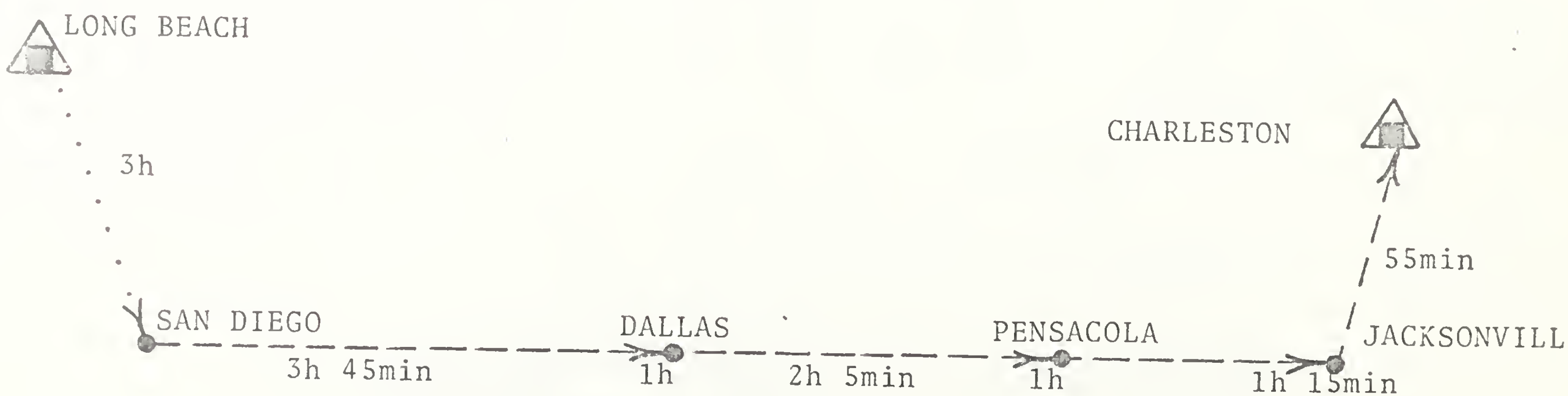


FIGURE 45

LONG BEACH to TRAVIS (via QUICKTRANS) to CLARK (via MAC)

Minimum total transport time = 3h + 1h 55min + 24h 55min (C-141) = 29h 50min = 1.24 day
Base histogram time = 35h + 24h 55min = 59h 55min = 2.5 day
(PRI-3 data sample insufficient)

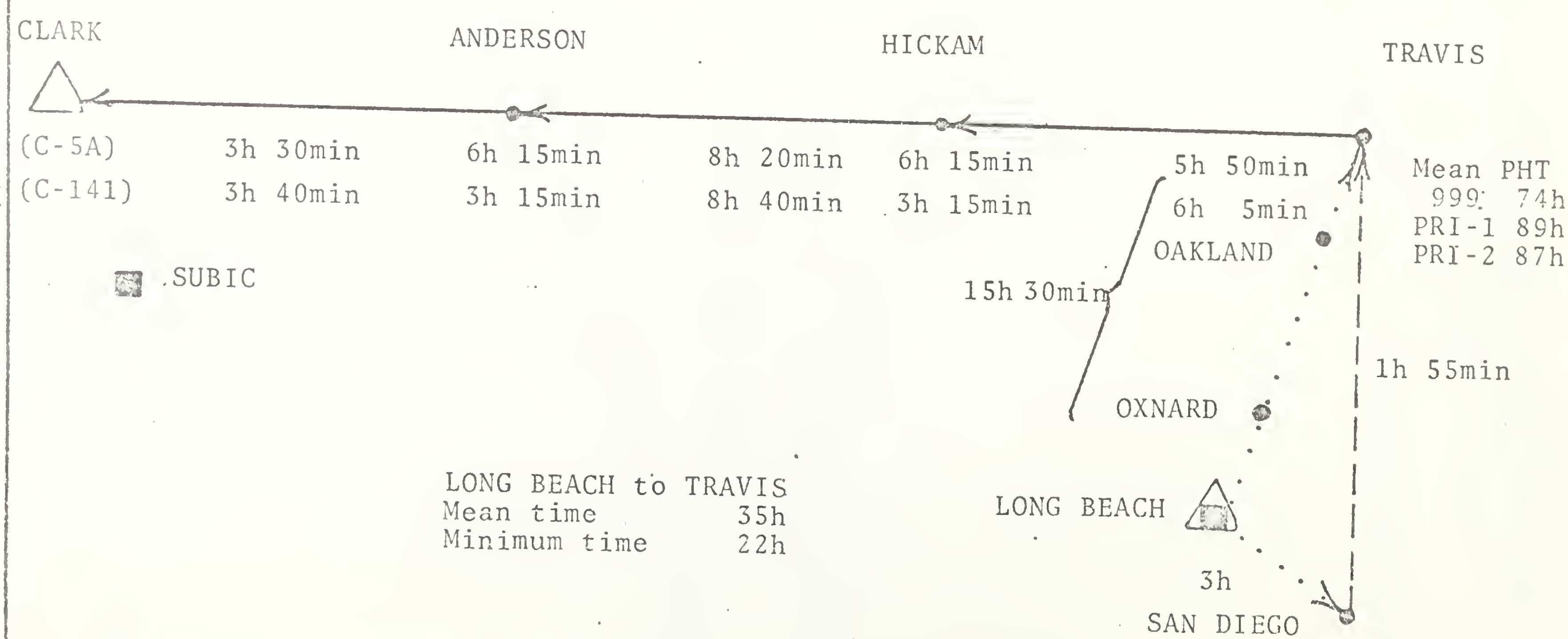


FIGURE 46

LONG BEACH to TRAVIS (via QUICKTRANS) to CLARK (via MAC)
999 CARGO Based on 587 shipments Jul-Dec 74
Minimum total transport time = 29h 50min = 1.24 day
Base histogram time = 59h 55min = 2.5 day

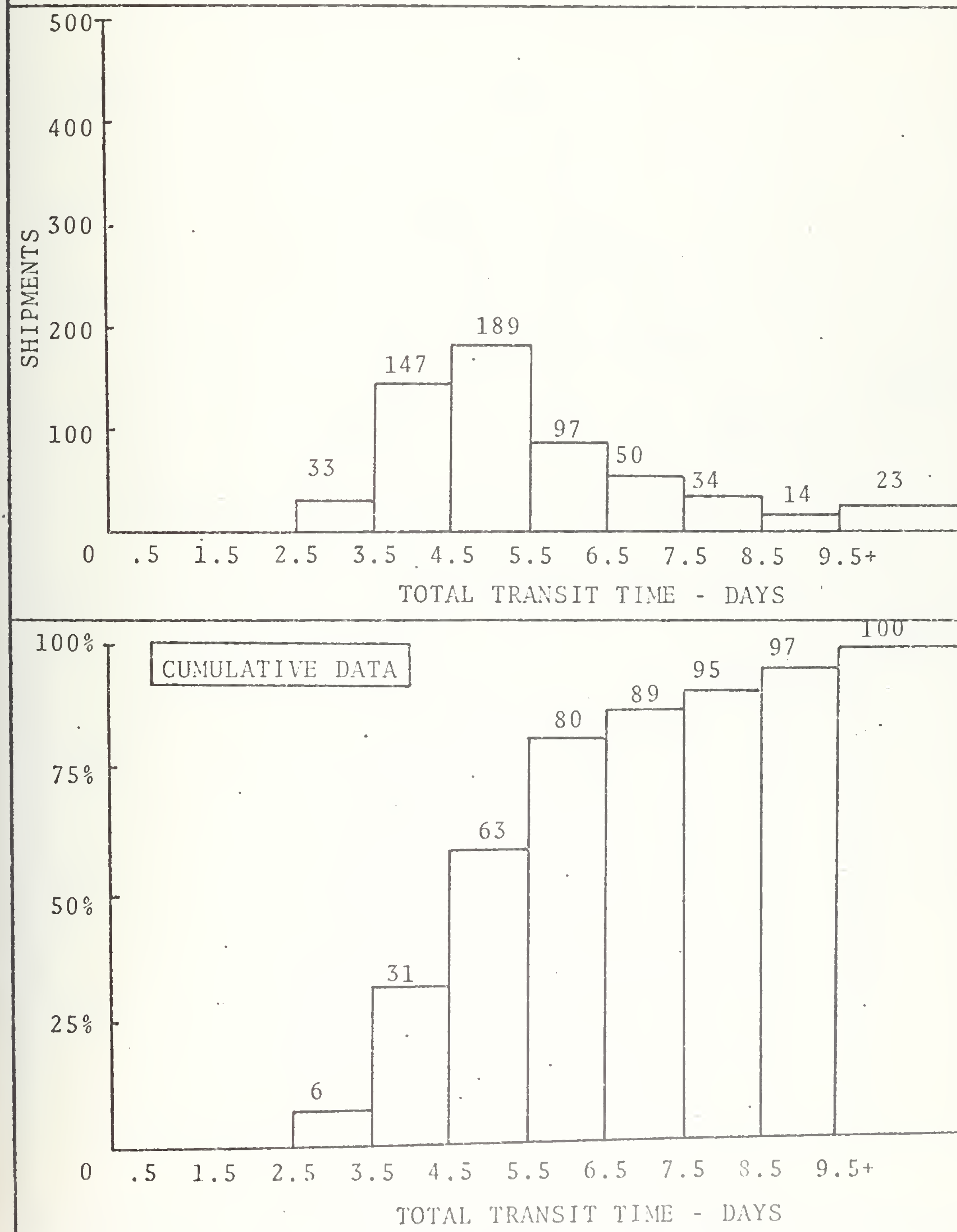
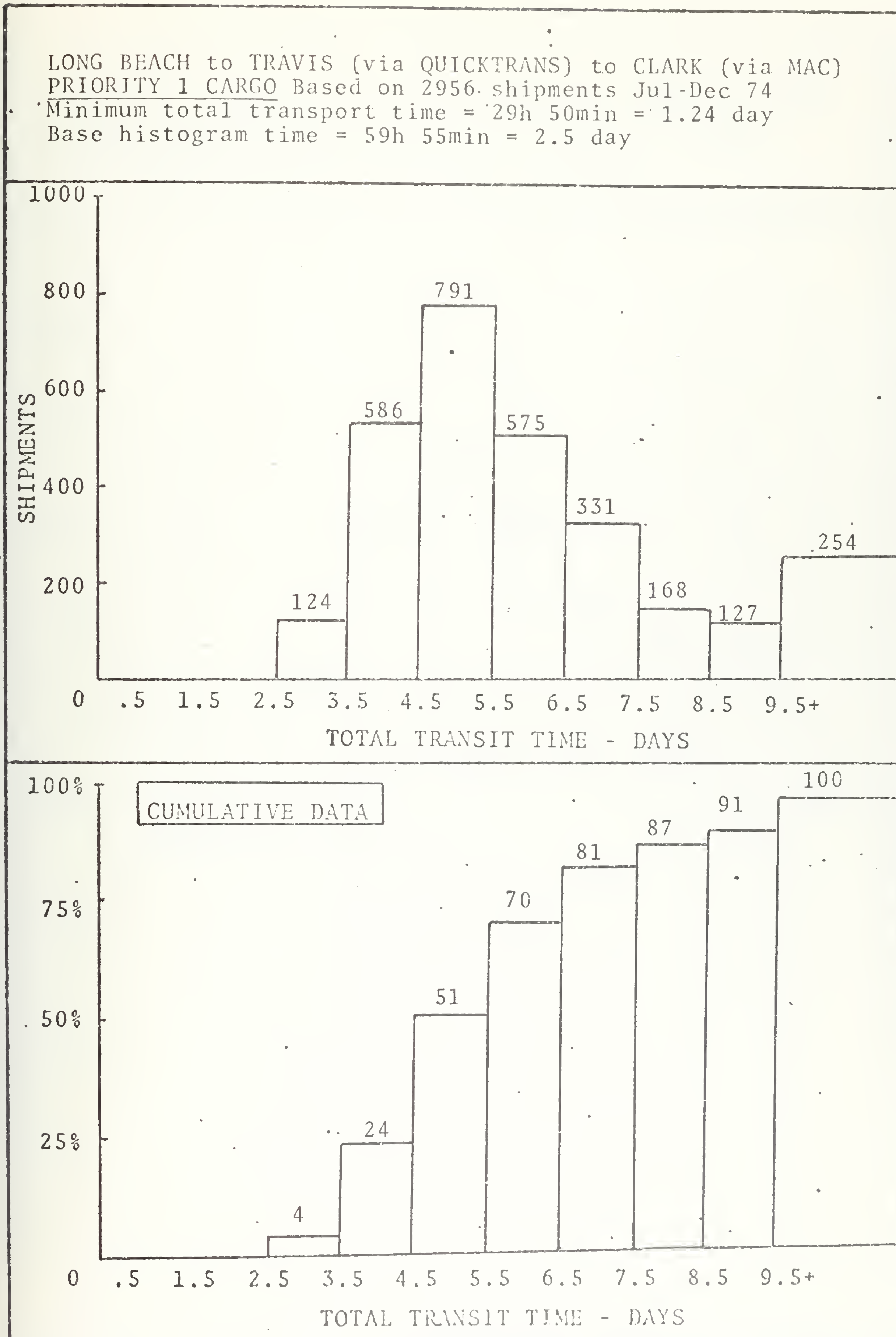


FIGURE 47



LONG BEACH to TRAVIS (via QUICKTRANS) to CLARK (via MAC)
PRIORITY 1 CARGO Based on 2956 shipments Jul-Dec 74
Minimum total transport time = 29h 50min = 1.24 day
Base histogram time = 59h 55min = 2.5 day
SHIPMENTS
1000
800
600
400
200
0
124
586
791
575
331
168
127
254
.5
1.5
2.5
3.5
4.5
5.5
6.5
7.5
8.5
9.5+
TOTAL TRANSIT TIME - DAYS
CUMULATIVE DATA
100%
75%
50%
25%
0
4
24
51
70
81
87
91
100
.5
1.5
2.5
3.5
4.5
5.5
6.5
7.5
8.5
9.5+
TOTAL TRANSIT TIME - DAYS

FIGURE 48

LONG BEACH to TRAVIS (via QUICKTRANS) to CLARK (via MAC)
PRIORITY 2 CARGO Based on 4198 shipments Jul-Dec 74
Minimum total transportation = 29h 50min = 1.24 day
Base histogram time = 59h 55min = 2.5 day

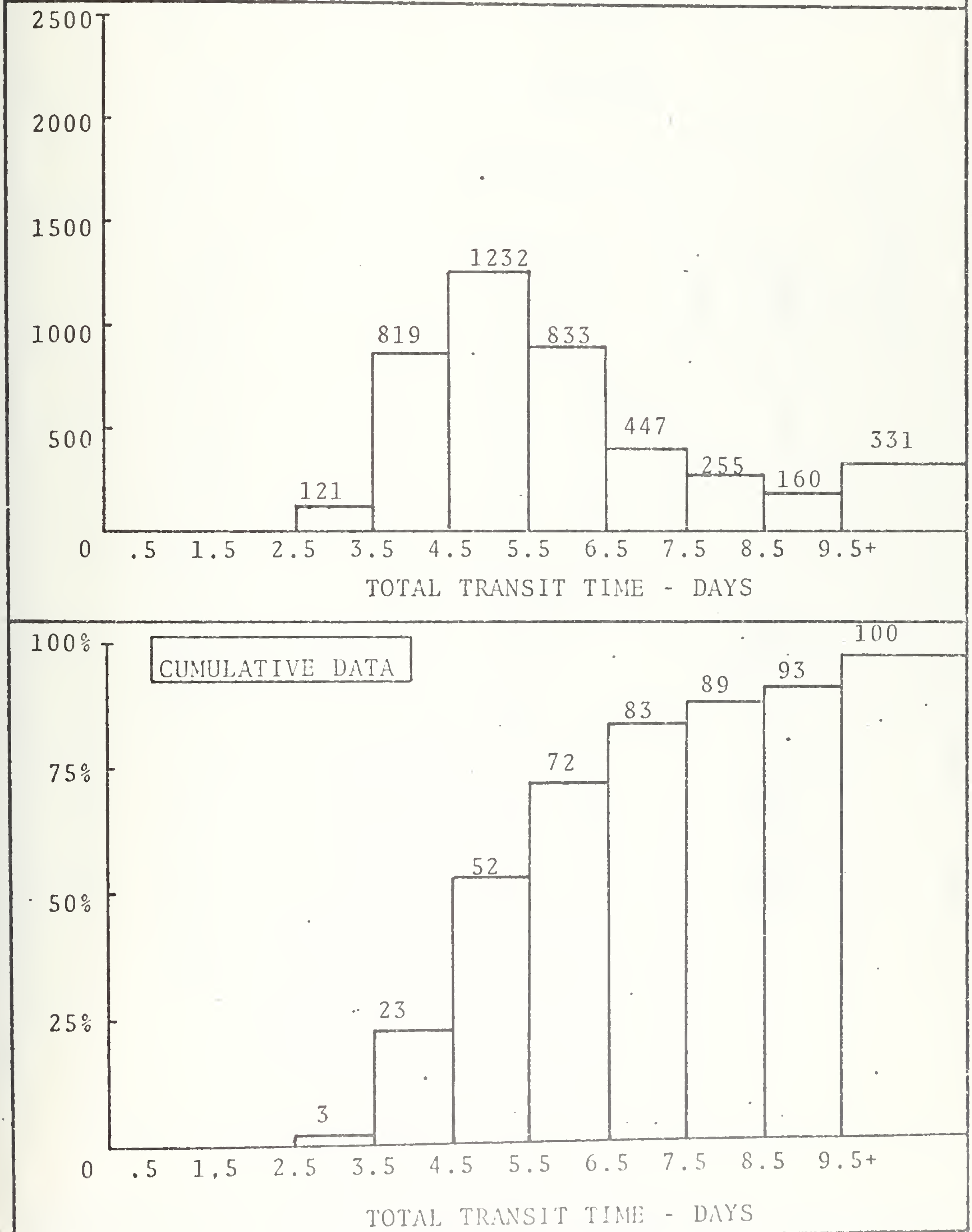


FIGURE 49

LONG BEACH to TRAVIS (via QUICKTRANS) to HICKAM (via MAC)

Minimum total transport time = 3h + 1h 55min + 5h 50min = 10h 45min = .45 day
Base histogram time = 35h + 5h 50min = 40h 50min = 1.71 day

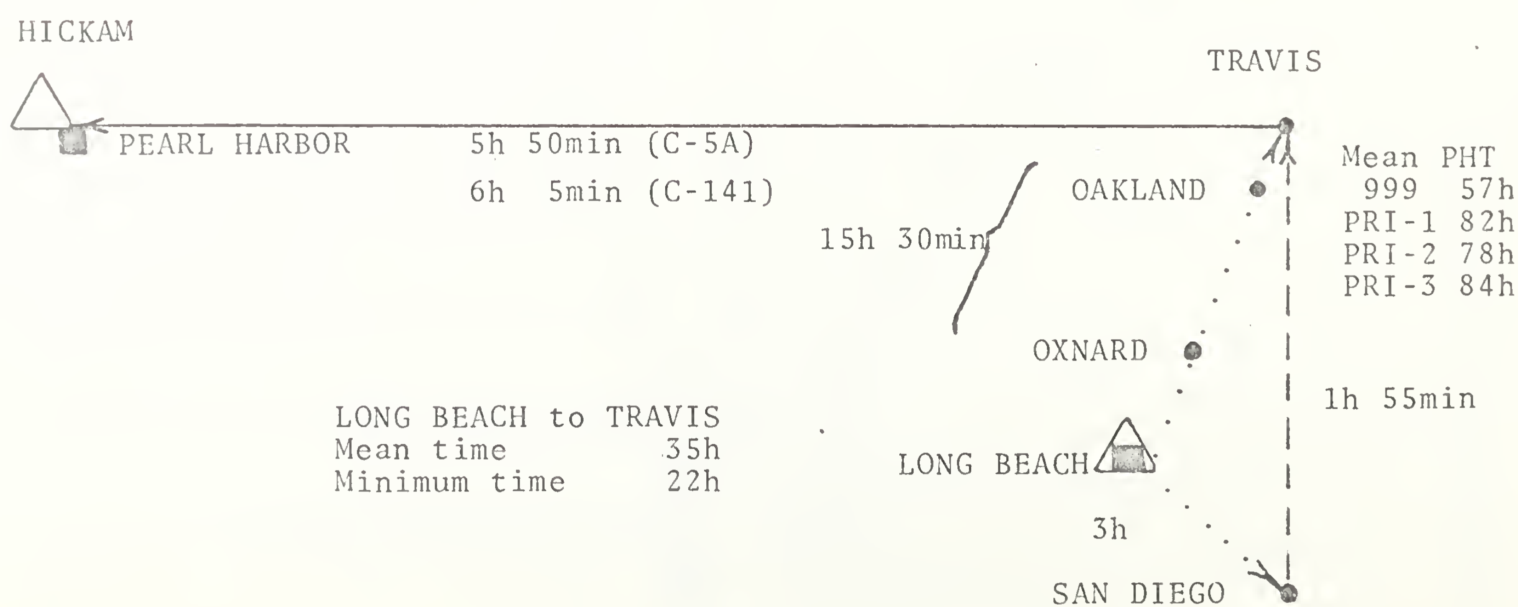
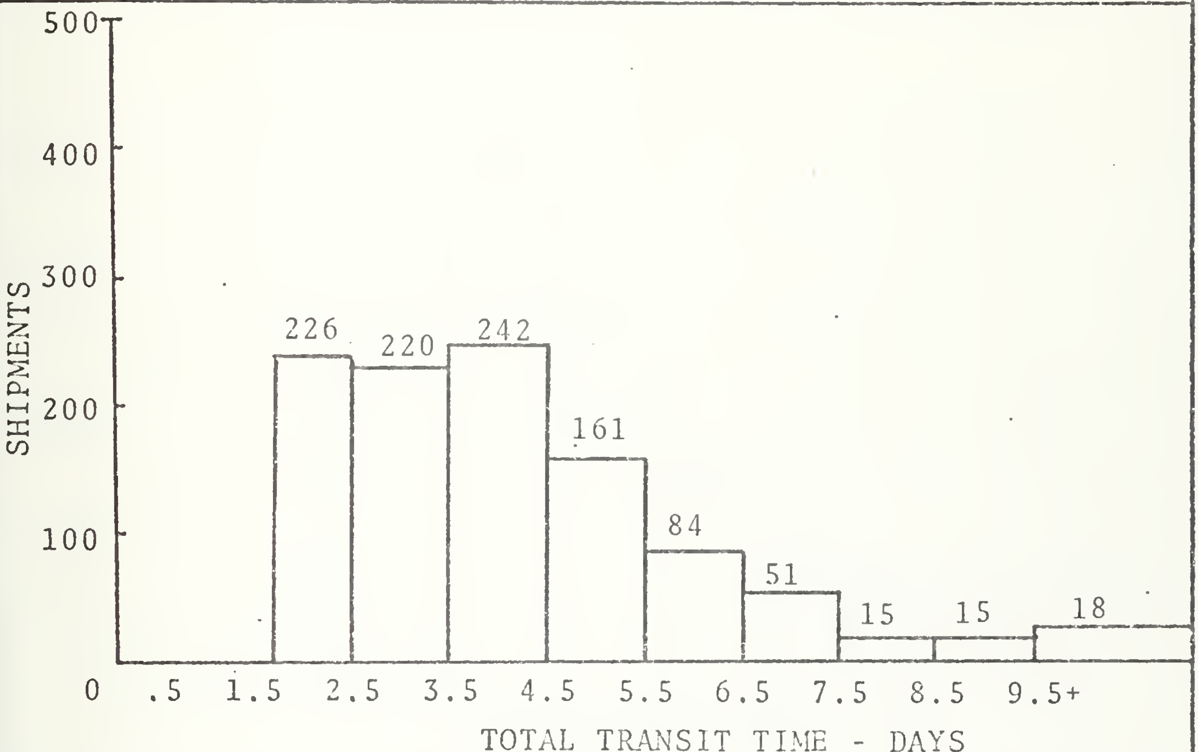


FIGURE 50

LONG BEACH to TRAVIS (via QUICKTRANS) to HICKAM (via MAC)
999 CARGO Based on 1032 shipments Jul-Dec 74
Minimum total transport time = 10h 45min = .45 day
Base histogram time = 40h 50min = 1.71 day



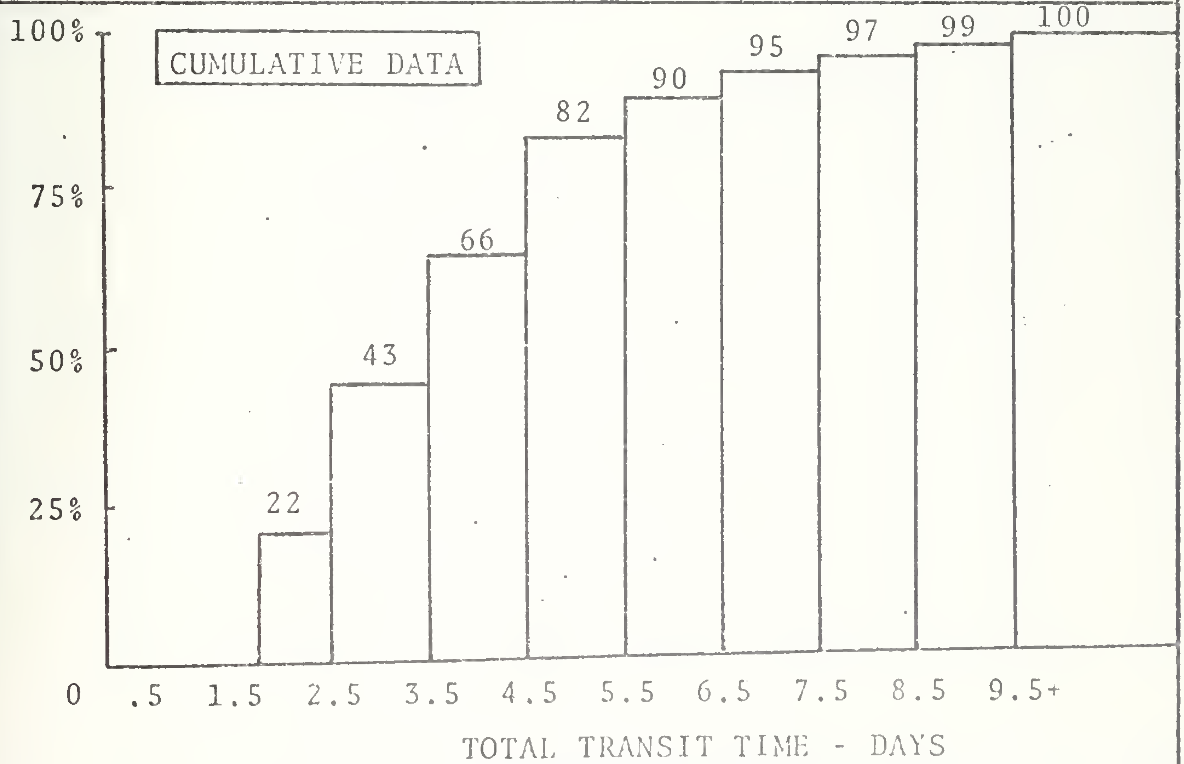
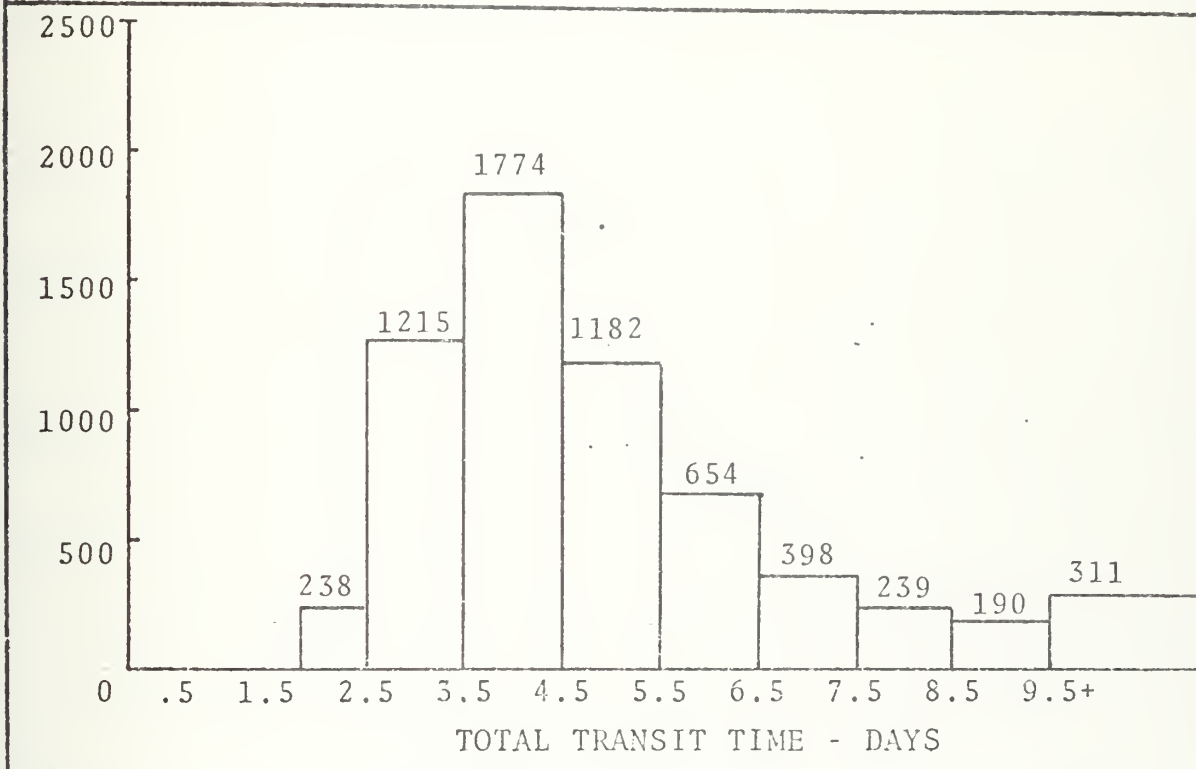


FIGURE 51

LONG BEACH to TRAVIS (via QUICKTRANS) to HICKAM (via MAC)
PRIORITY 1 CARGO Based on 6201 shipments Jul-Dec 74
Minimum total transport time = 10h 45min = .45 day
Base histogram time = 40h 50min = 1.71 day



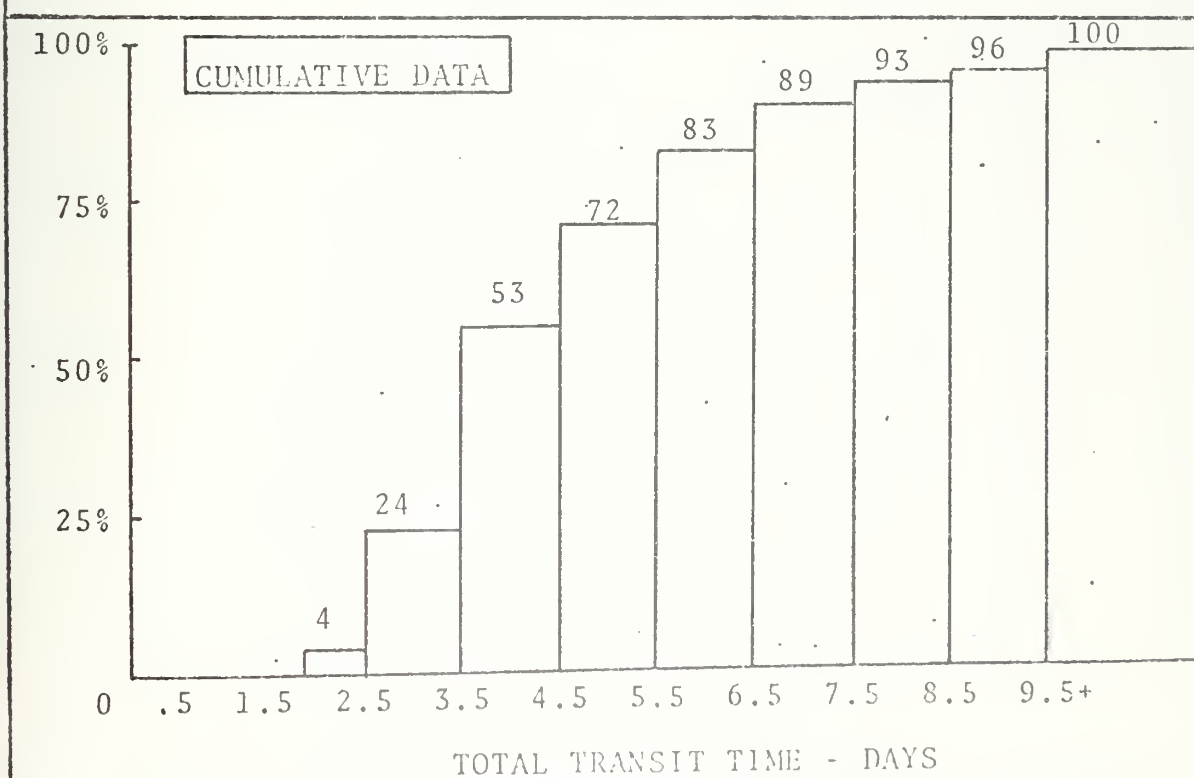


FIGURE 52

LONG BEACH to TRAVIS (via QUICKTRANS) to HICKAM (via MAC)
PRIORITY 2 CARGO Based on 8591 shipments Jul-Dec 74
Minimum total transport time = 10h 45min = .45 day
Base histogram time = 40h 50min = 1.71 day

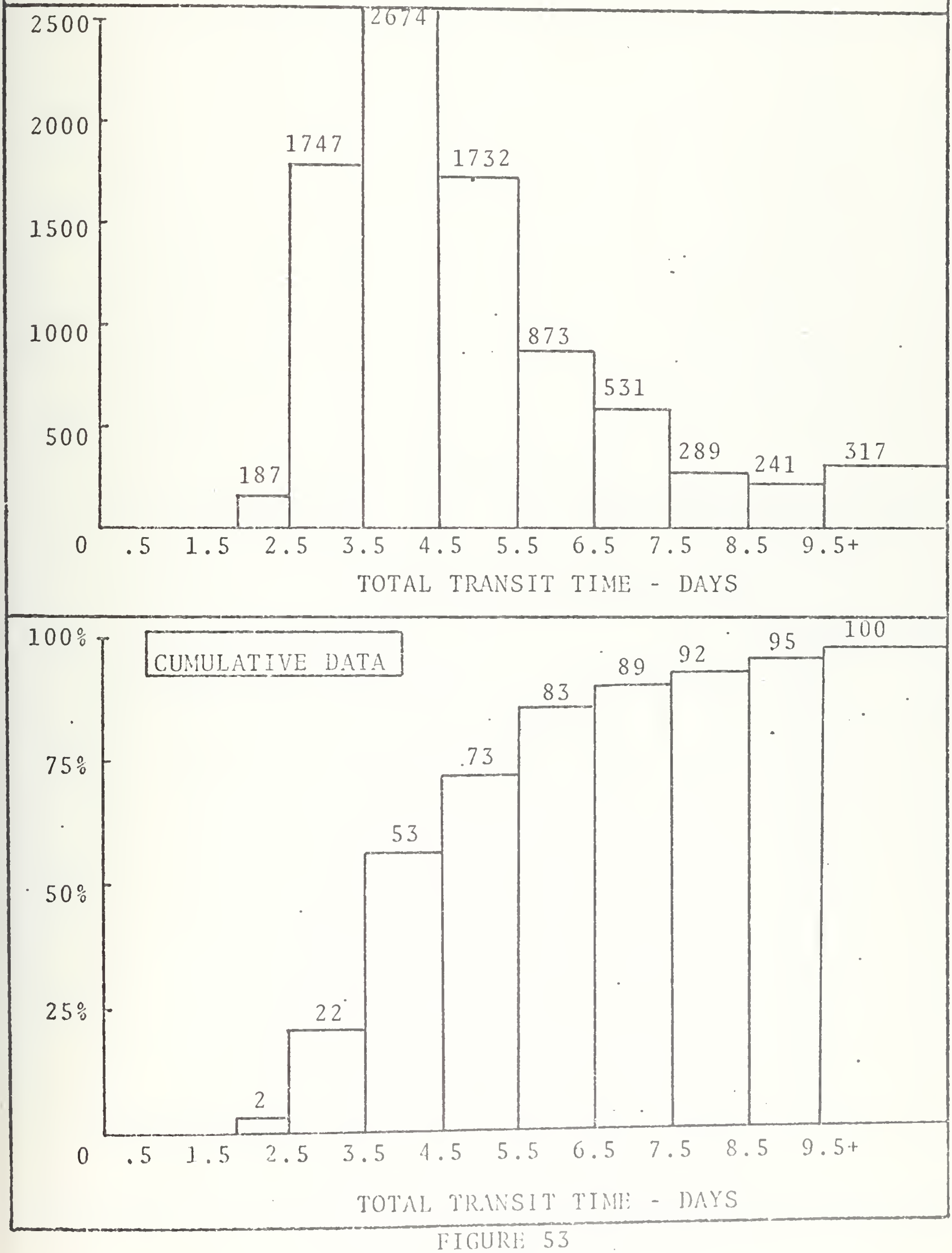


FIGURE 53

LONG BEACH to TRAVIS (via QUICKTRANS) to HICKAM (via MAC)
PRIORITY 3 CARGO Based on 175 shipments Jul-Dec 74
Minimum total transport time = 10h 45min = .45 day
Base histogram time = 40h 50min = 1.71 day

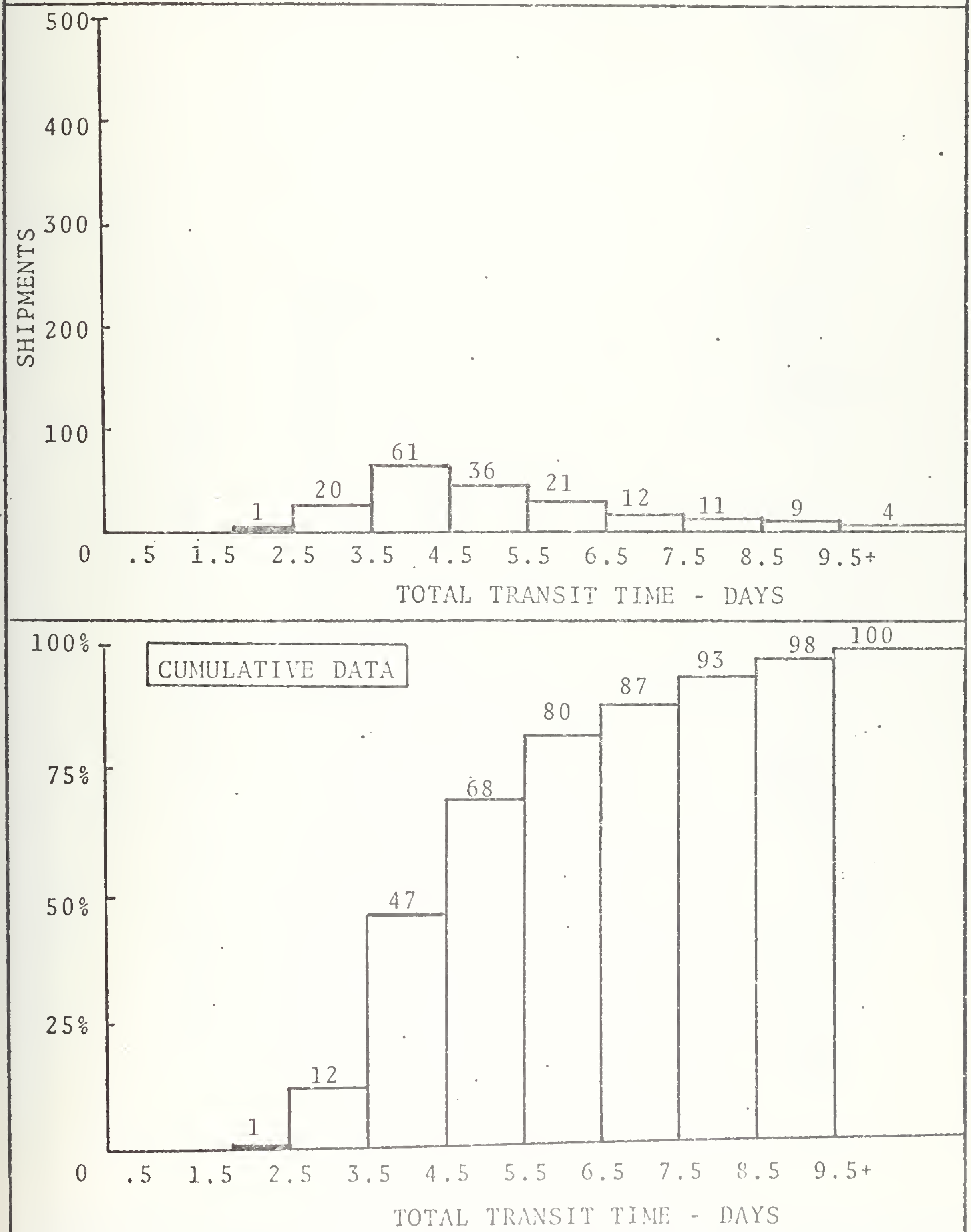


FIGURE 54

LONG BEACH to JACKSONVILLE (via QUICKTRANS)

Mininum total transport time = 12h 10min = .5 day

LONG BEACH to JACKSONVILLE

Mean time	57h
Minimum time	20h

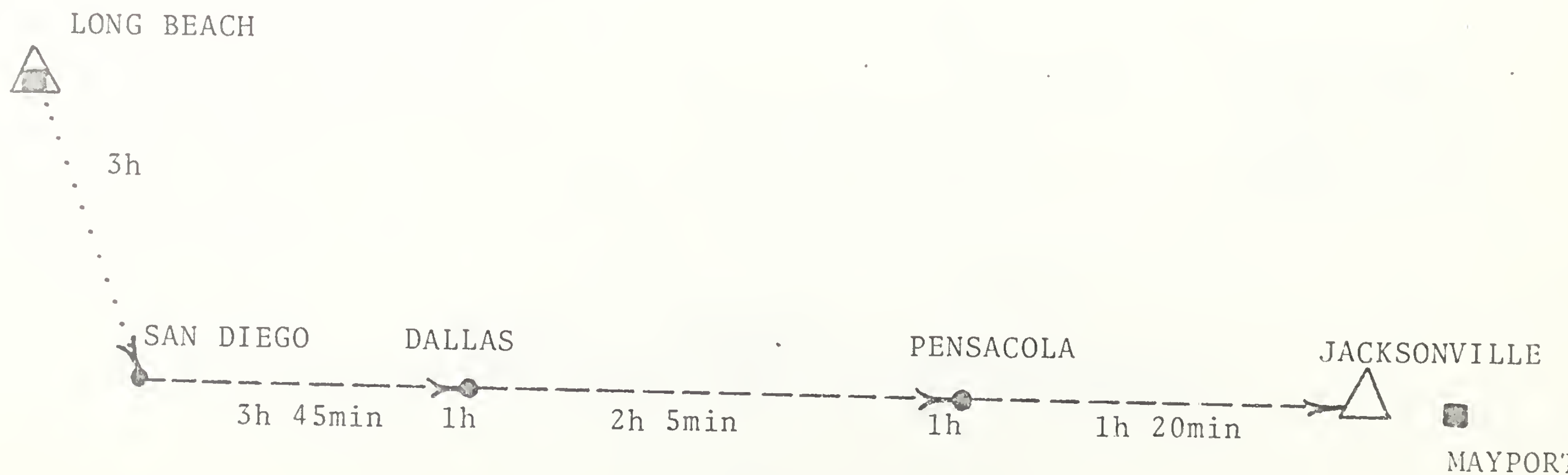


FIGURE 55

LONG BEACH to NORFOLK (via QUICKTRANS) to NAPLES (via MAC)

Minimum total transport time = 25h 40min = 1.07 day
Base histogram time = 62h + 14h 5min = 76h 5min = 3.17 day
(PRI-3 Data sample insufficient)

LONG BEACH to NORFOLK	
Mean time	62h
Minimum time	25h

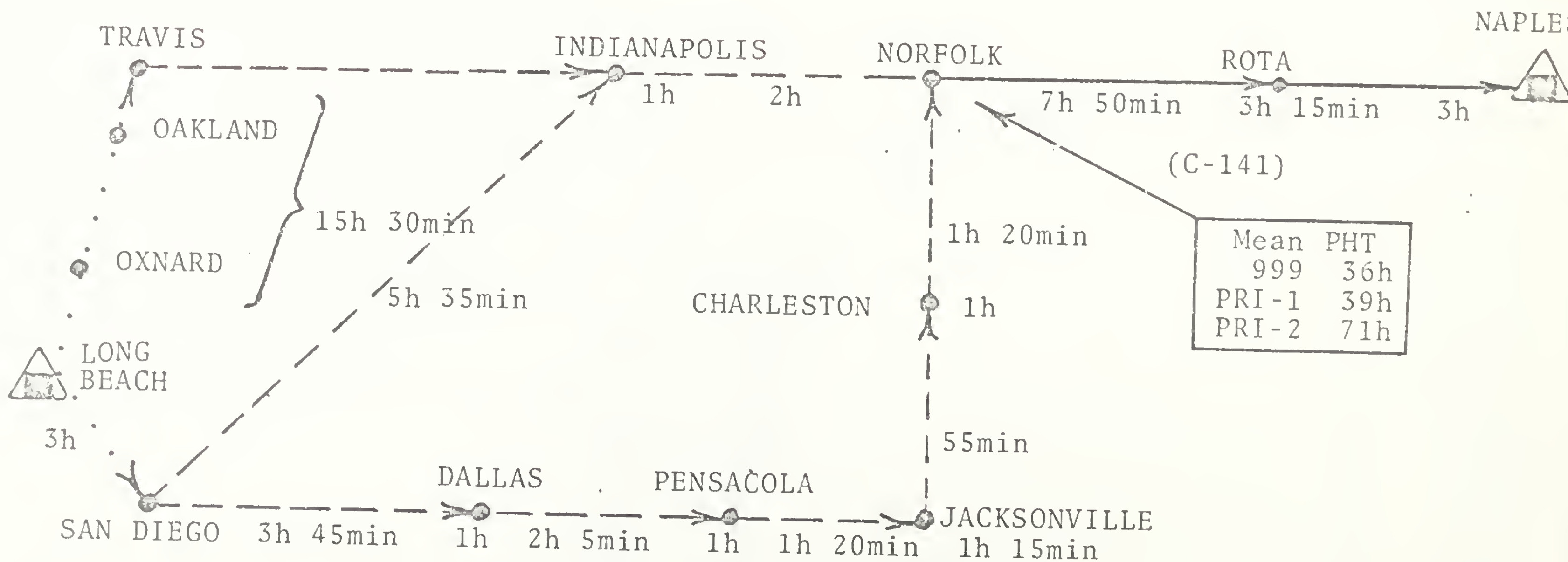
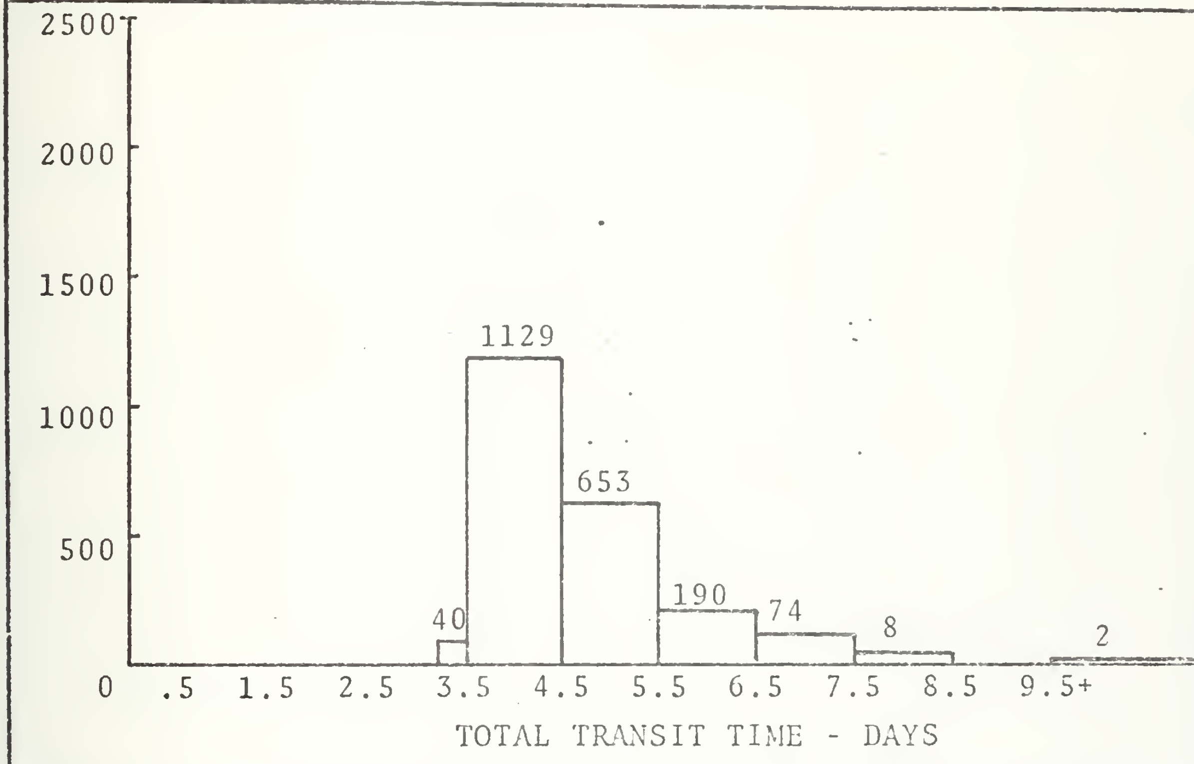


FIGURE 56

LONG BEACH to NORFOLK (via QUICKTRANS) to NAPLES (via MAC)
999 CARGO Based on 2096 shipments Jul-Dec 74
Minimum total transport time = 25h 40min = 1.07 day
Base histogram time = 76h 5min = 3.17 day



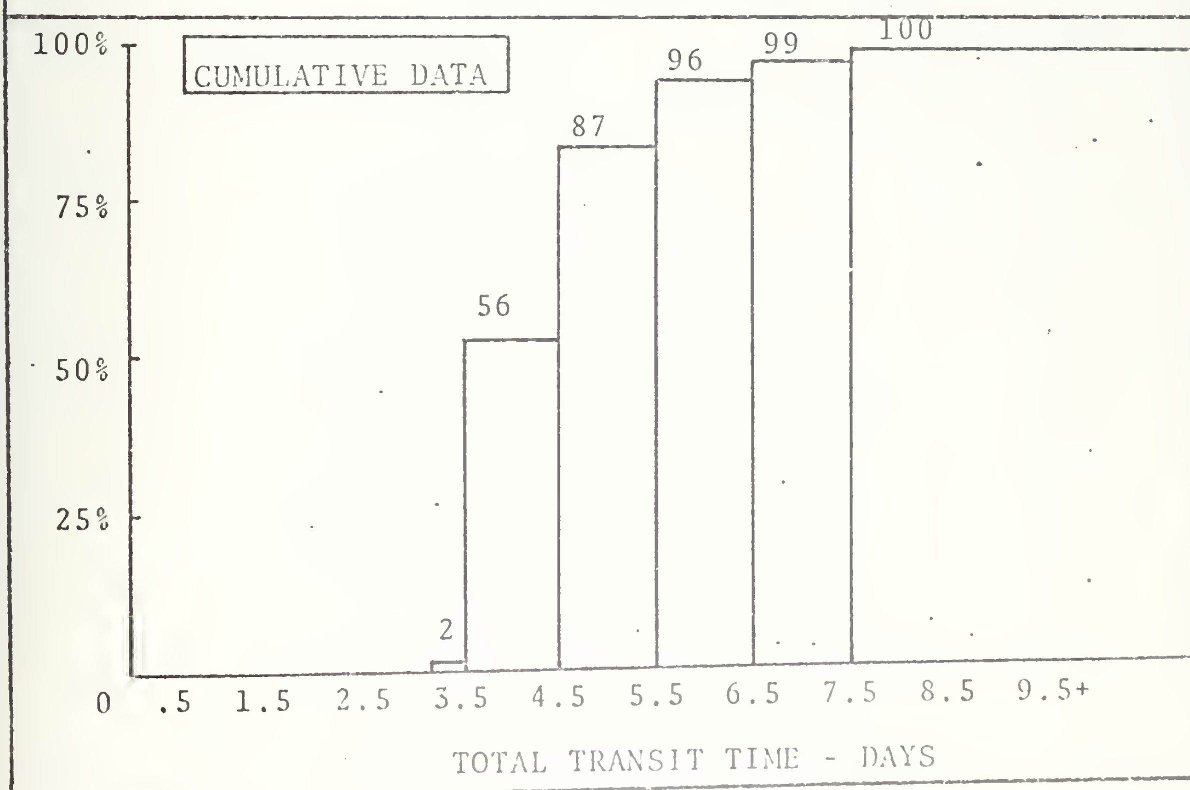


FIGURE 57

LONG BEACH to NORFOLK (via QUICKTRANS) to NAPLES (via MAC)
PRIORITY 1 CARGO Based on 3083 shipments Jul-Dec 74
Minimum total transport time = 25h 40min = 1.07 day
Base histogram time = 76h 5 min = 3.17 day

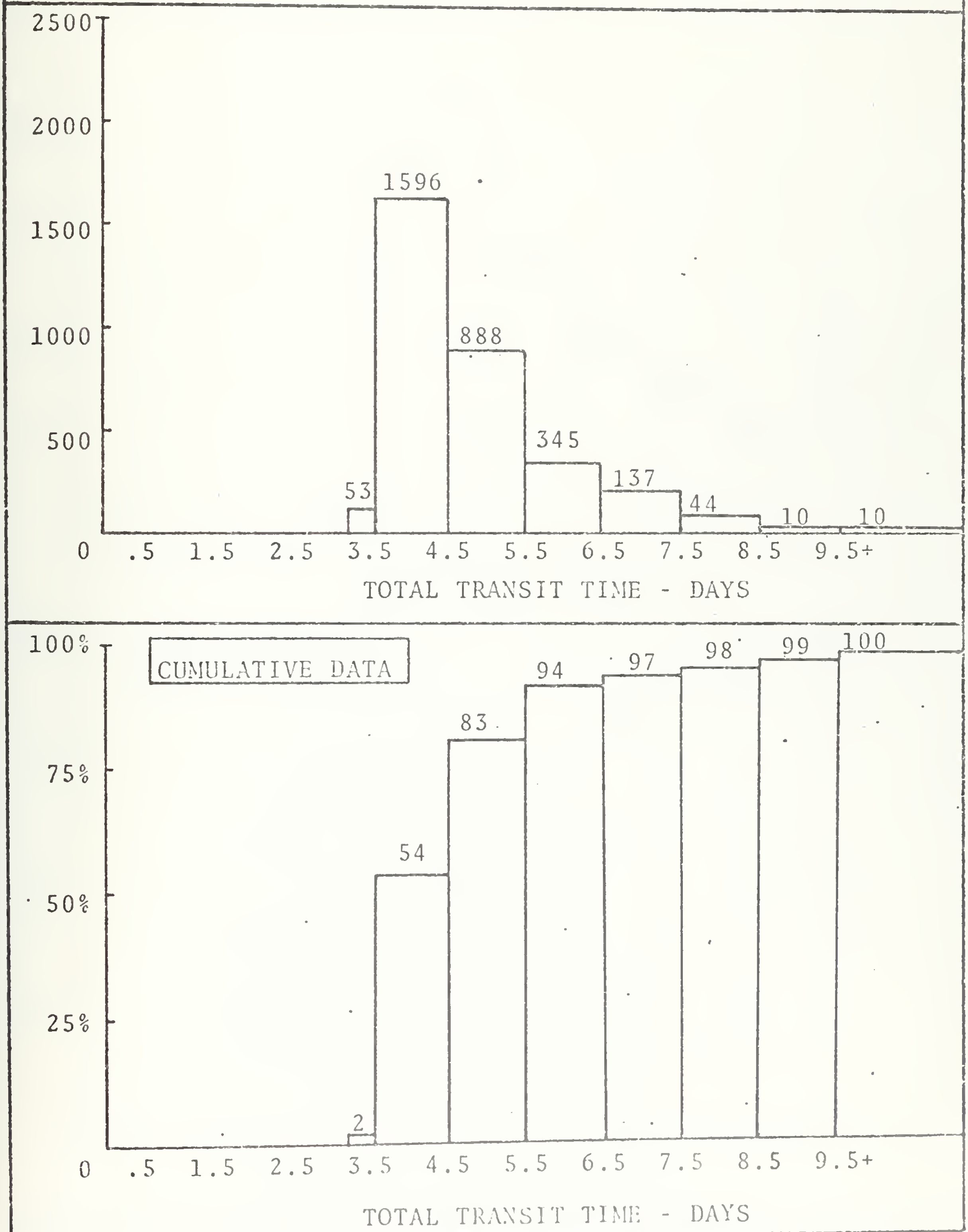
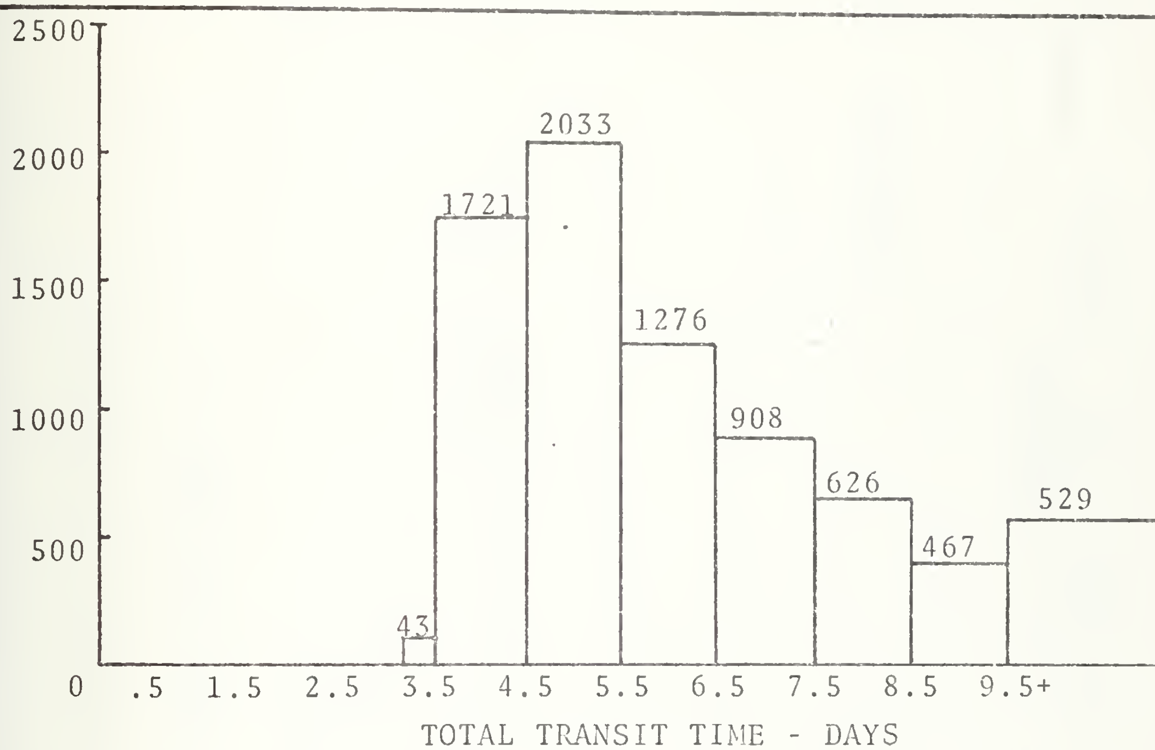


FIGURE 58

LONG BEACH to NORFOLK (via QUICKTRANS) to NAPLES (via MAC)
PRIORITY 2 CARGO Based on 7603 shipments Jul-Dec 74
Minimum total transport time = 25h 40min = 1.07 day
Base histogram time = 76h 5min = 3.17 day



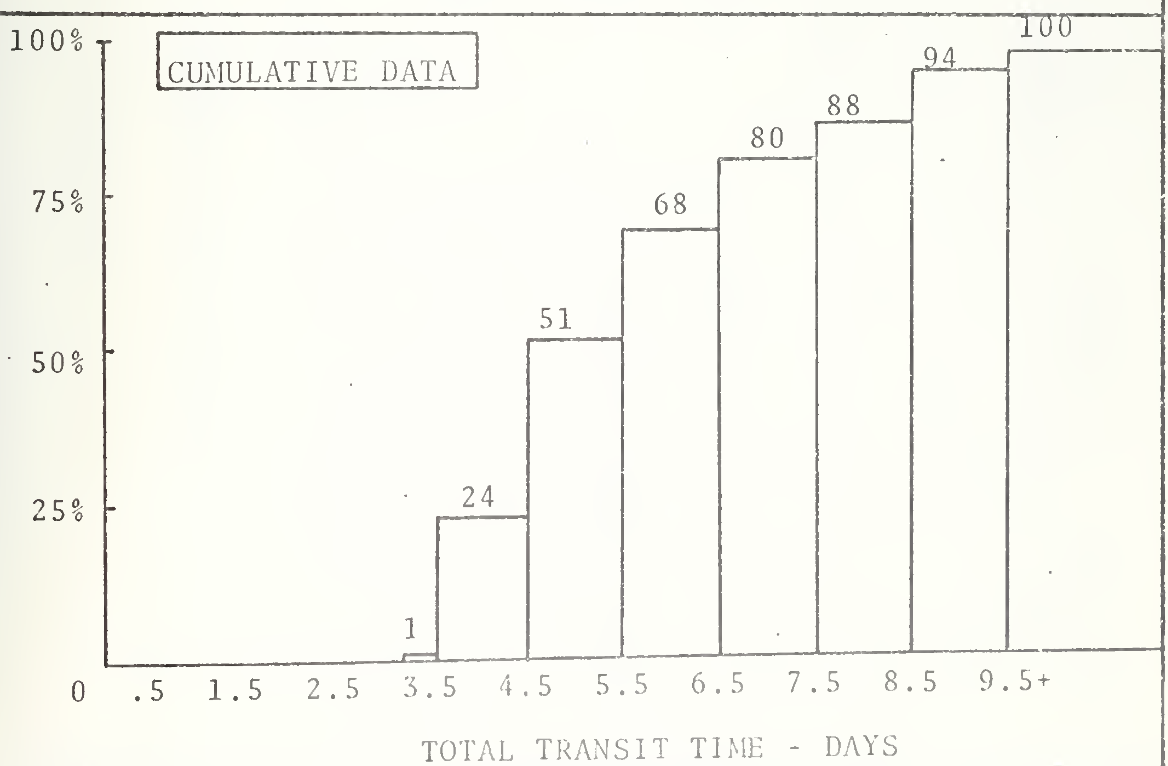


FIGURE 59

LONG BEACH to NORFOLK (via QUICKTRANS)

Minimum total transport time = 11h 35min

LONG BEACH to NORFOLK	
Mean time	62h
Minimum time	25h

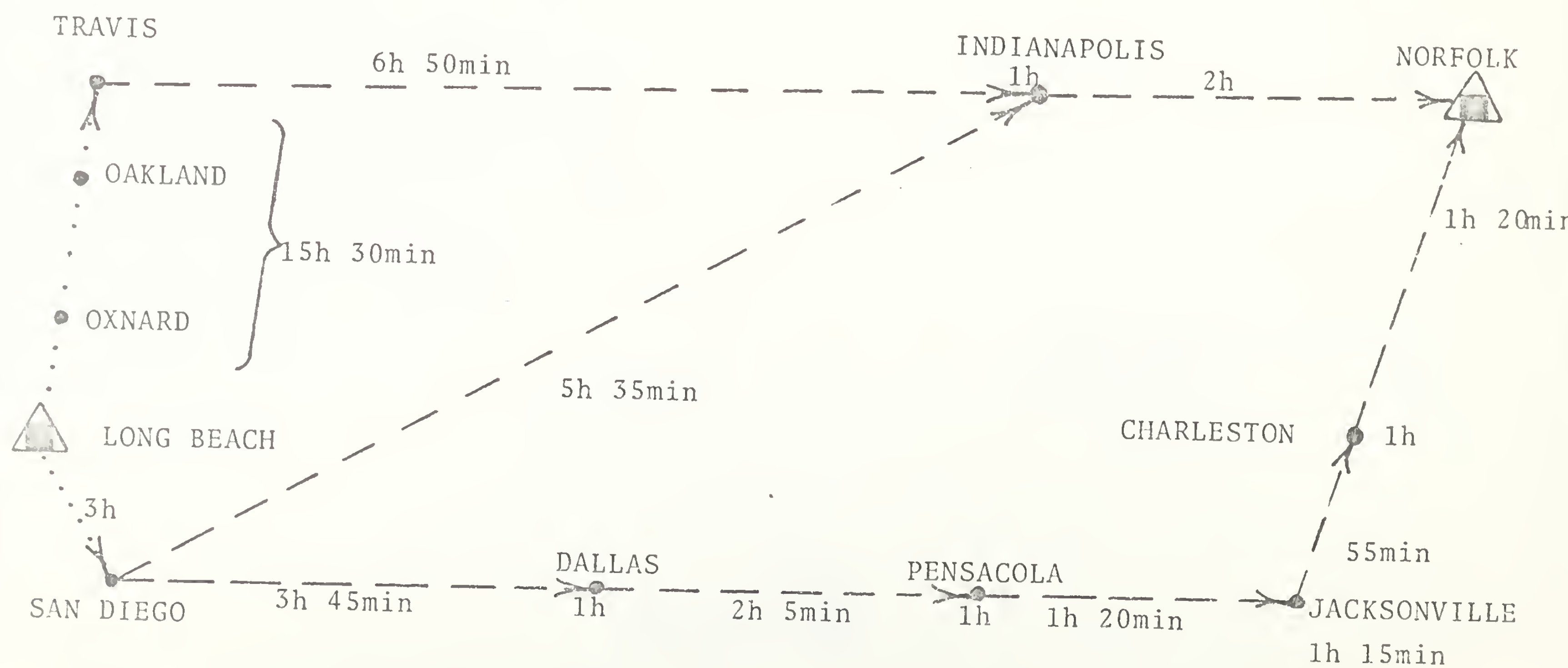
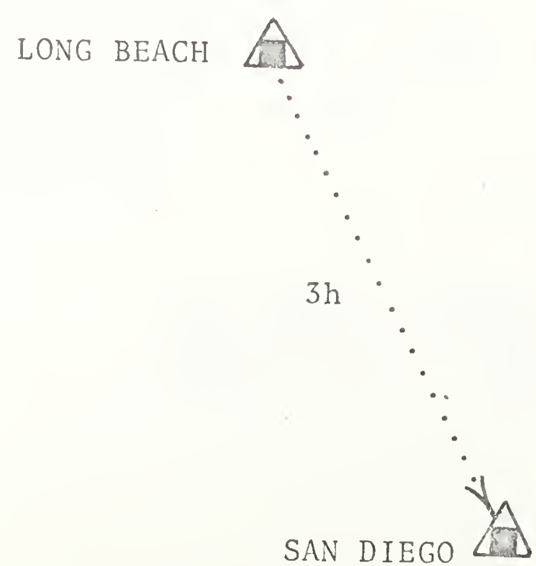


FIGURE 60

LONG BEACH to SAN DIEGO (via QUICKTRANS)

Minimum total transport time = 3h = .125 day



LONG BEACH to SAN DIEGO	
Mean time	19h
Minimum time	5h

FIGURE 61

LONG BEACH to TRAVIS (via QUICKTRANS) to YOKOTA (via MAC)

Minimum total transport time = 3h + 1h 55min + 55h 20min = 60h 15min = 2.51 day
Base histogram time = 35h + 55h 20min = 90h 20min = 3.76 day
(PRI-2, 3 and 999 data sample insufficient)

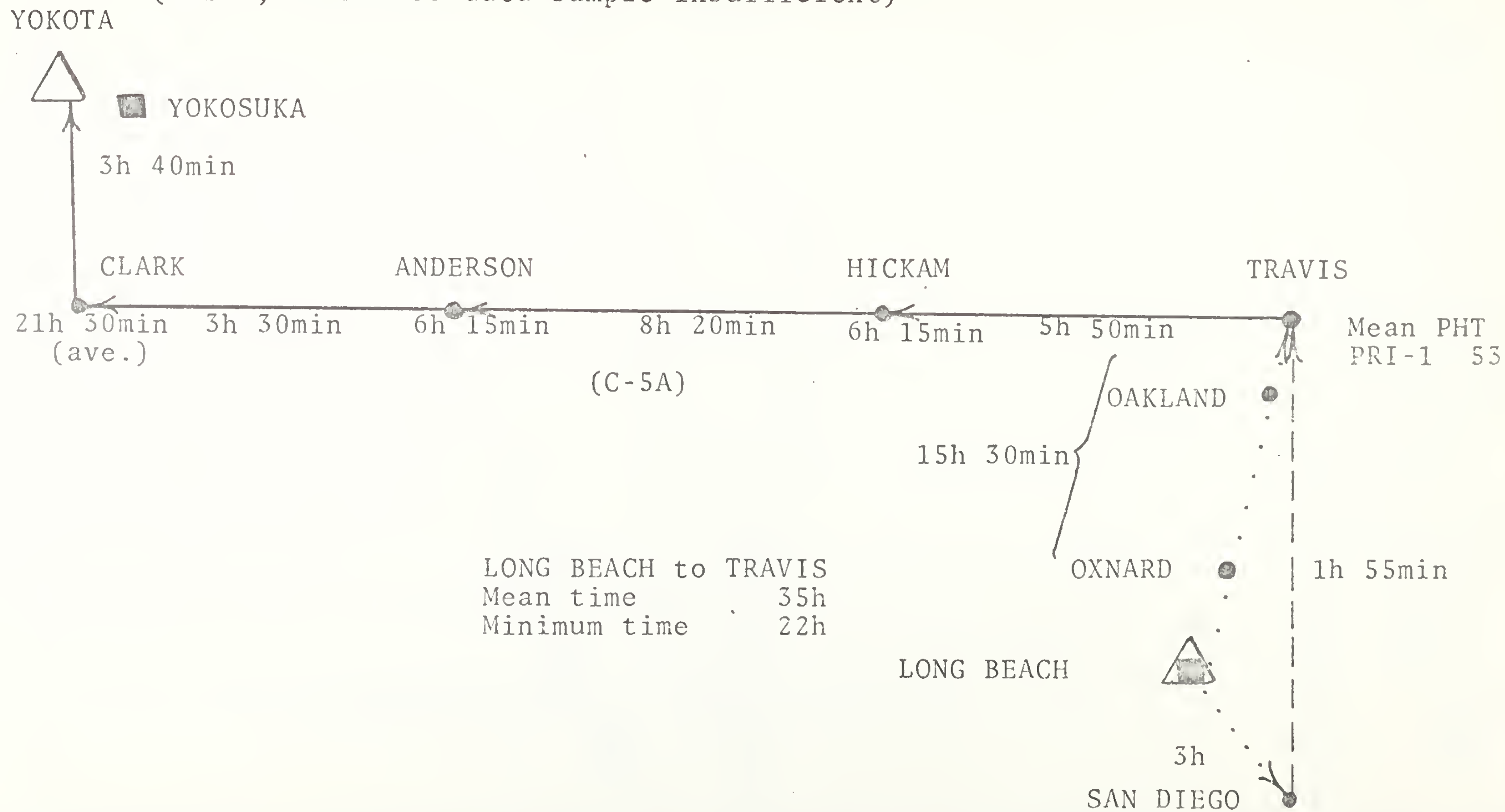


FIGURE 62

LONG BEACH to TRAVIS (via QUICKTRANS) to YOKOTA (via MAC)
PRIORITY 1 CARGO Based on 278 shipments Jul-Dec 74
Minimum total transport time = 60h 15min = 2.51 day
Base histogram time = 90h 20min = 3.76 day

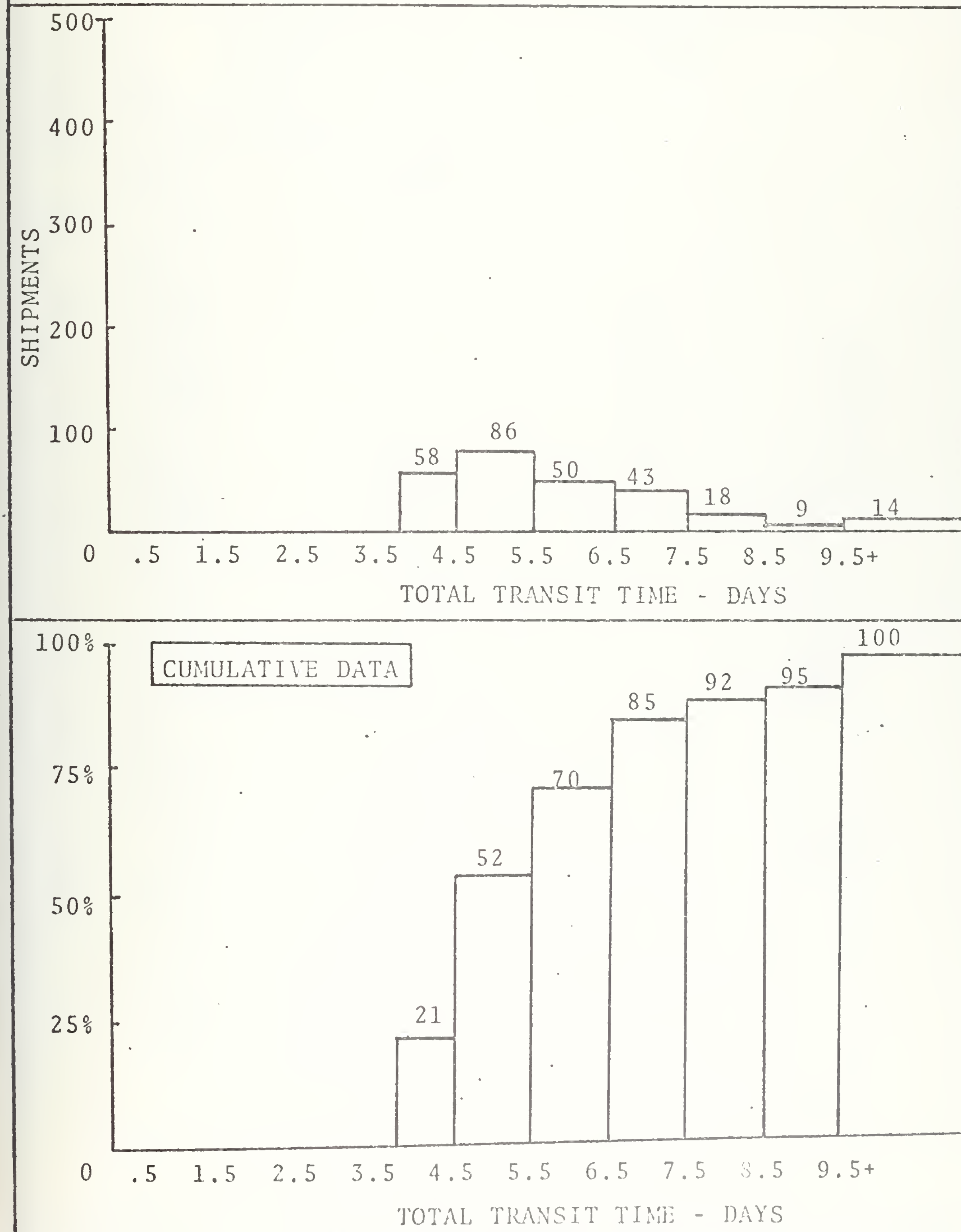


FIGURE 63

NAPLES to NORFOLK (via MAC) to LONG BEACH (via QUICKTRANS)

Minimum total transport time = 31h 15min + 13h 35min = 44h 50min = 1.87 day
Base histogram time = 31h 15min + 98h = 129h 15min = 5.38 day
(See NAPLES-NORFOLK & NORFOLK-LONGBEACH figures for time data)

Mean	PHT
999	56h
PRI-1	56h
PRI-2	65h
PRI-3	91h

NORFOLK to LONG BEACH	
Mean time	98h
Minimum time	21h

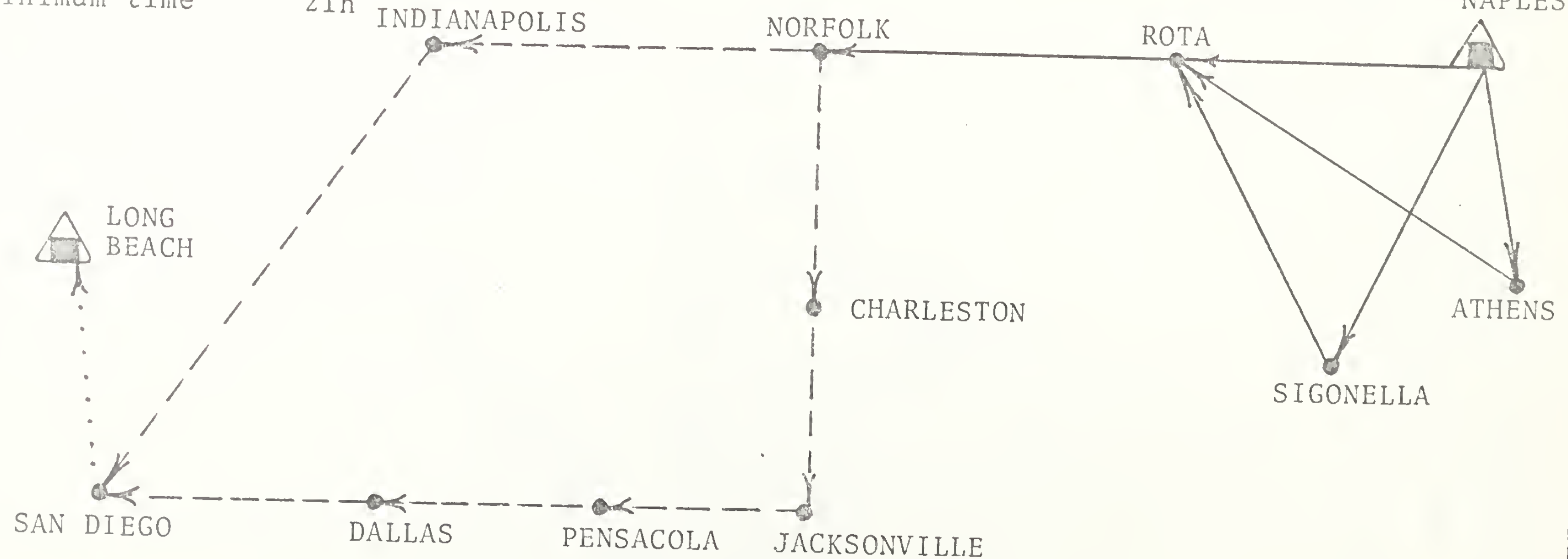


FIGURE 64

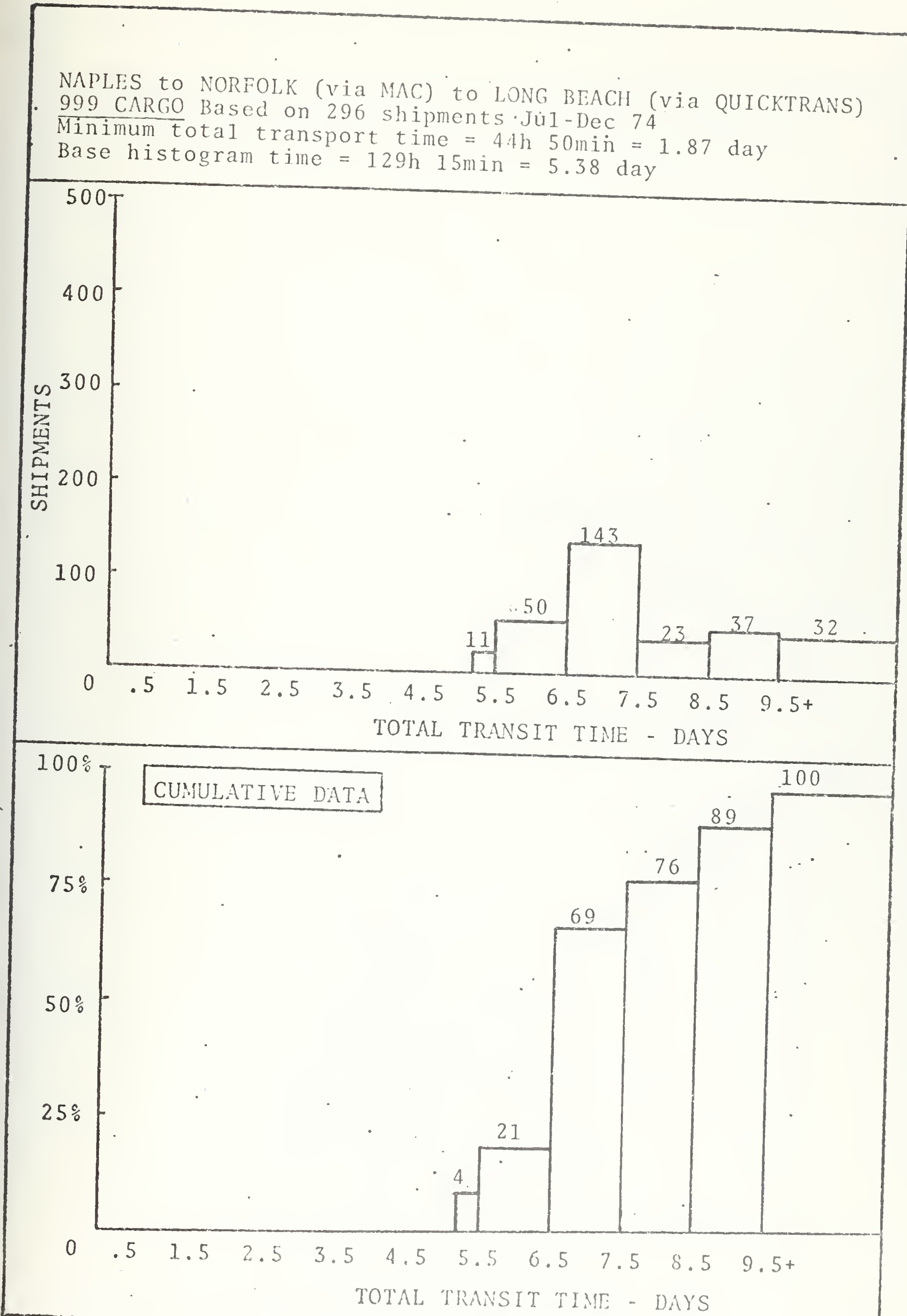
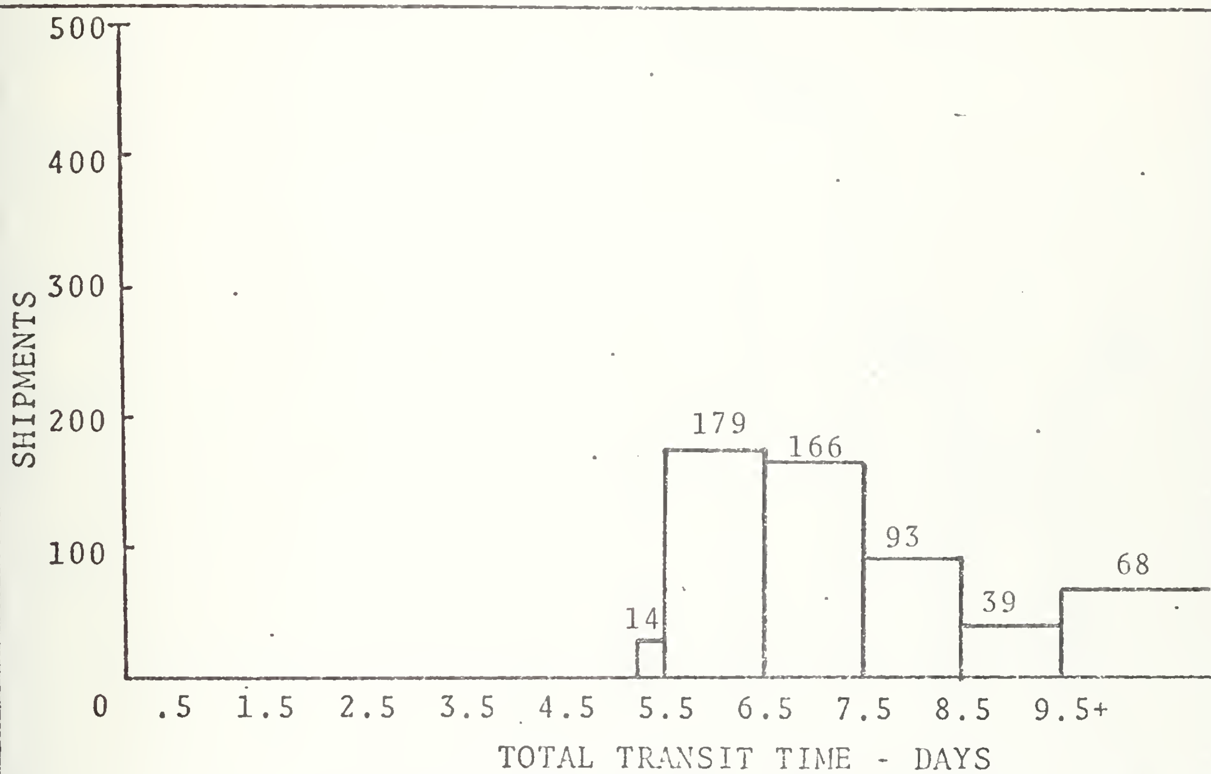

NAPLES to NORFOLK (via MAC) to LONG BEACH (via QUICKTRANS)
999 CARGO Based on 296 shipments Jul-Dec 74
Minimum total transport time = 44h 50min = 1.87 day
Base histogram time = 129h 15min = 5.38 day
SHIPMENTS
500
400
300
200
100
0
11
50
143
23
37
32
.5
1.5
2.5
3.5
4.5
5.5
6.5
7.5
8.5
9.5+
TOTAL TRANSIT TIME - DAYS
CUMULATIVE DATA
100%
75%
50%
25%
0
4
21
69
76
89
100
.5
1.5
2.5
3.5
4.5
5.5
6.5
7.5
8.5
9.5+
TOTAL TRANSIT TIME - DAYS

FIGURE 65

NAPLES to NORFOLK (via MAC) to LONG BEACH (via QUICKTRANS)
PRIORITY 1 CARGO Based on 554 Shipments Jul-Dec 74
Minimum total transport time = 44h 50min = 1.87 day
Base histogram time = 129h 15min = 5.38 day



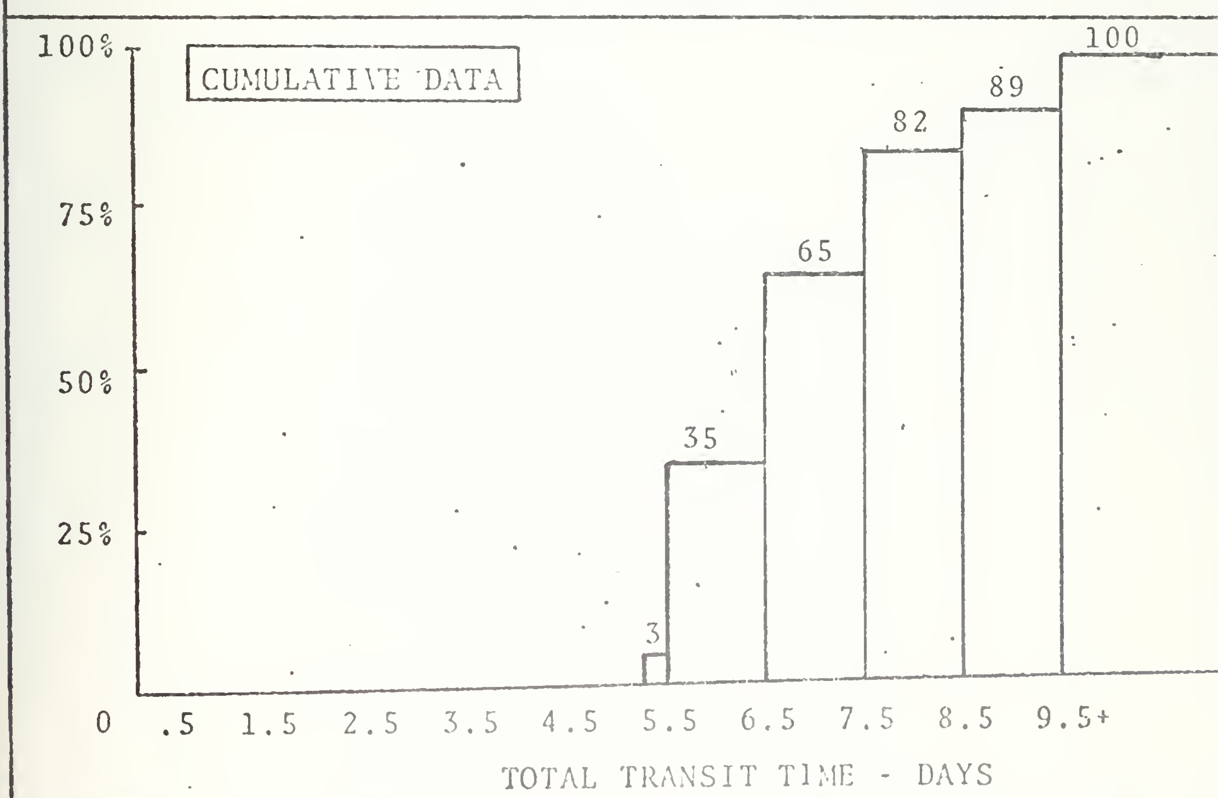


FIGURE 66

NAPLES to NORFOLK (via MAC) to LONG BEACH (via QUICKTRANS)
PRIORITY 2 CARGO Based on 1566 shipments Jul-Dec 74
Minimum total transport time = 44h 50min = 1.87 day
Base histogram time = 129h 15min = 5.38 day

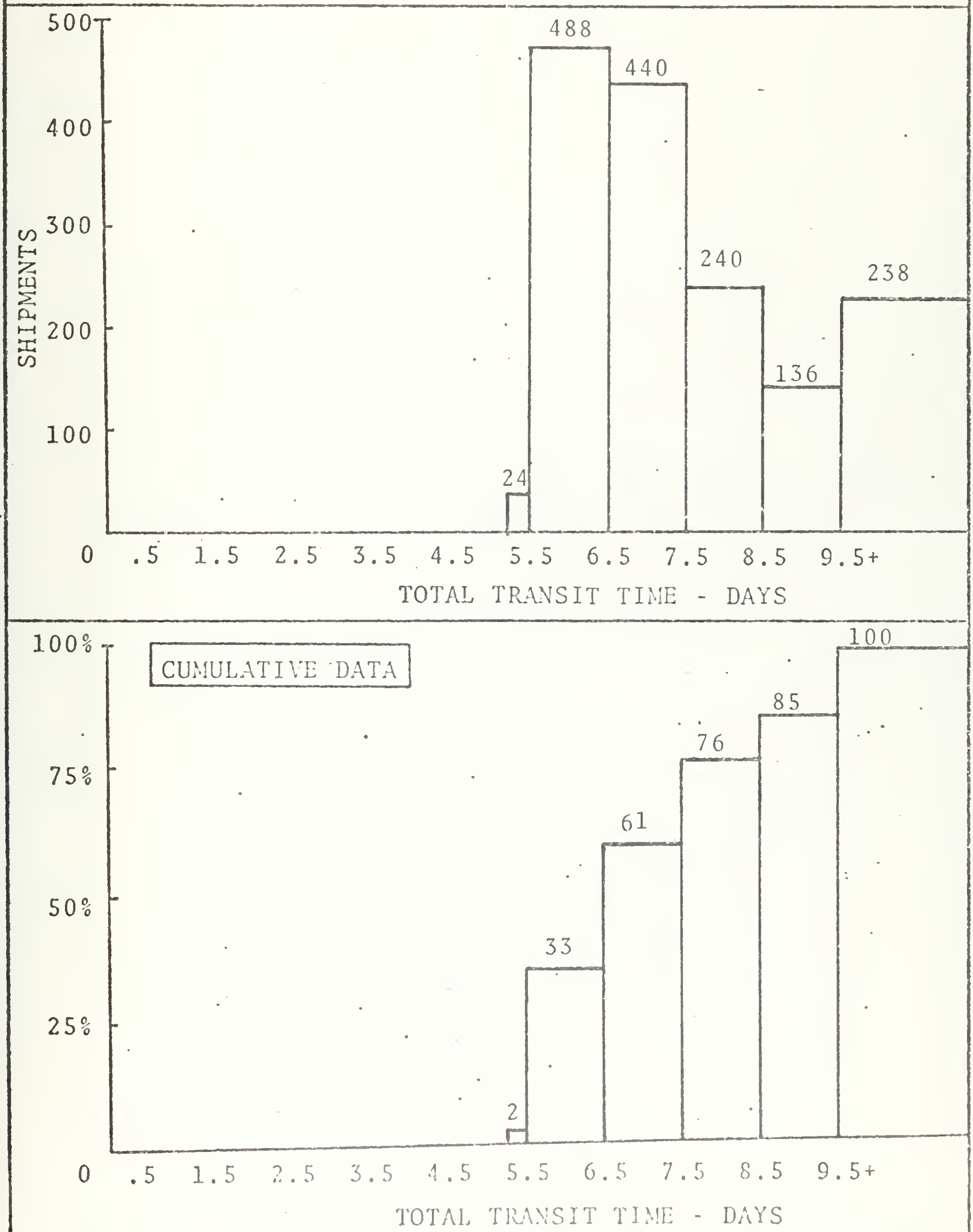
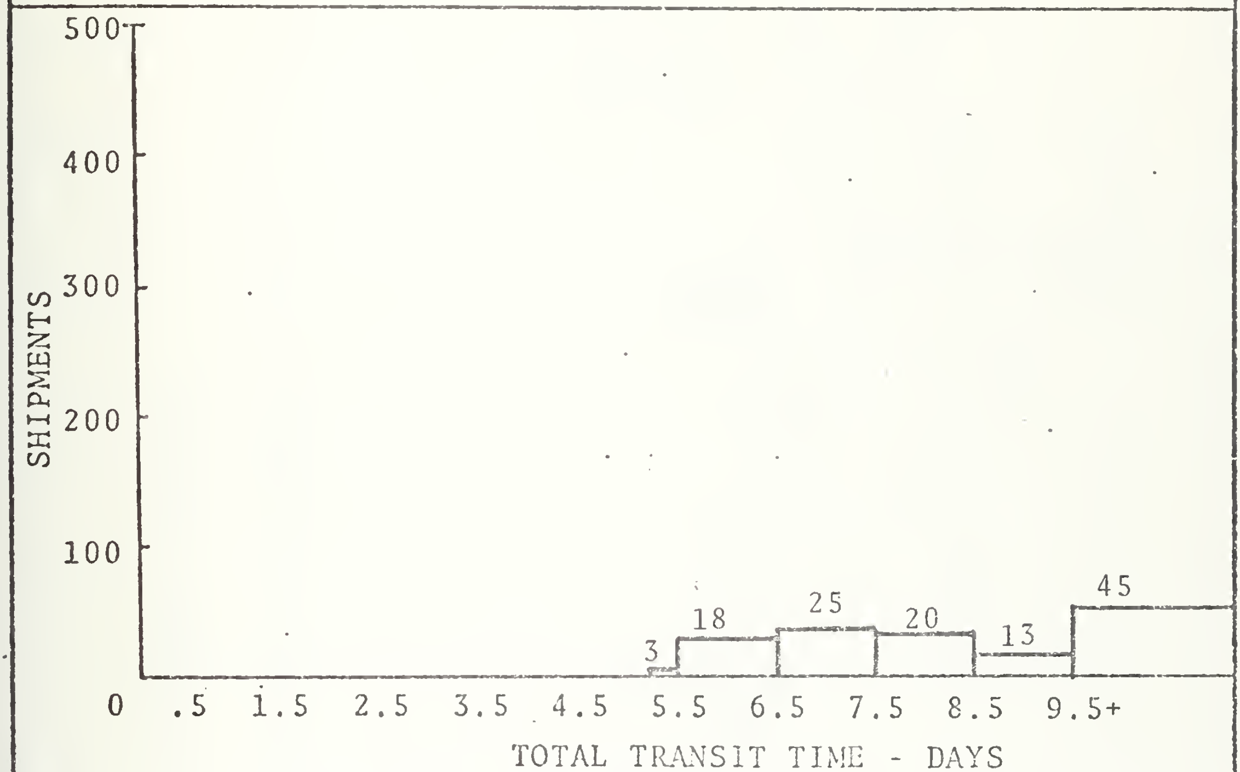


FIGURE 67

NAPLES to NORFOLK (via MAC) to LONG BEACH (via QUICKTRANS)
PRIORITY 3 CARGO Based on 124 shipments Jul-Dec 74
Minimum total transport time = 44h 50min = 1.87 day
Base histogram time = 129h 15min = 5.38 day



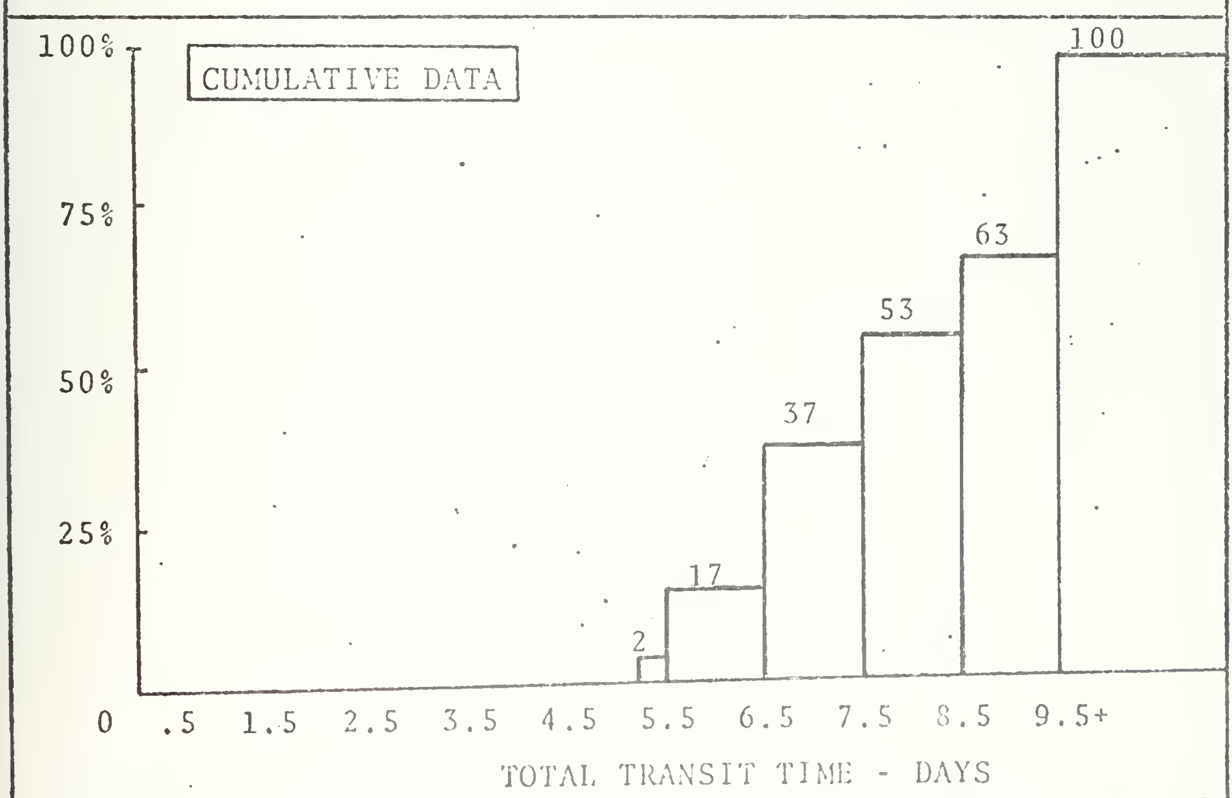


FIGURE 68

NAPLES to NORFOLK (via MAC)

Minimum total transport time = 31h 15min = 1.30 day
Base histogram time = 31h 15min = 1.30 day

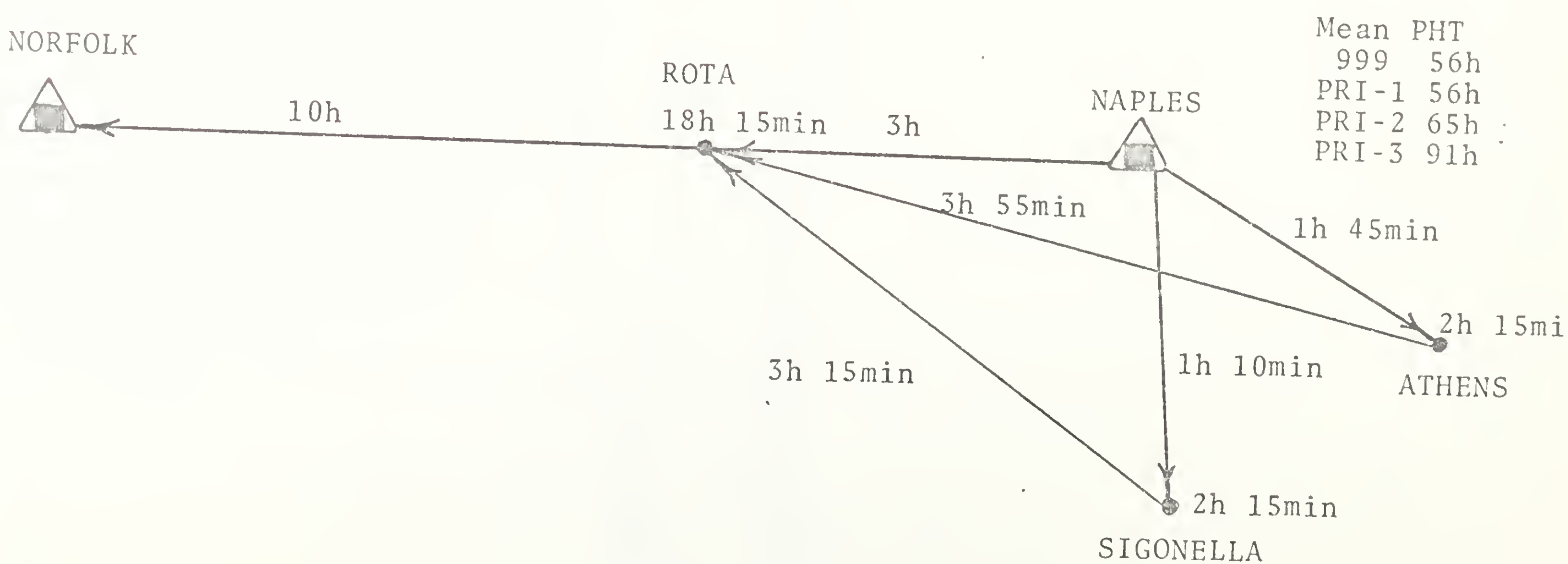


FIGURE 69

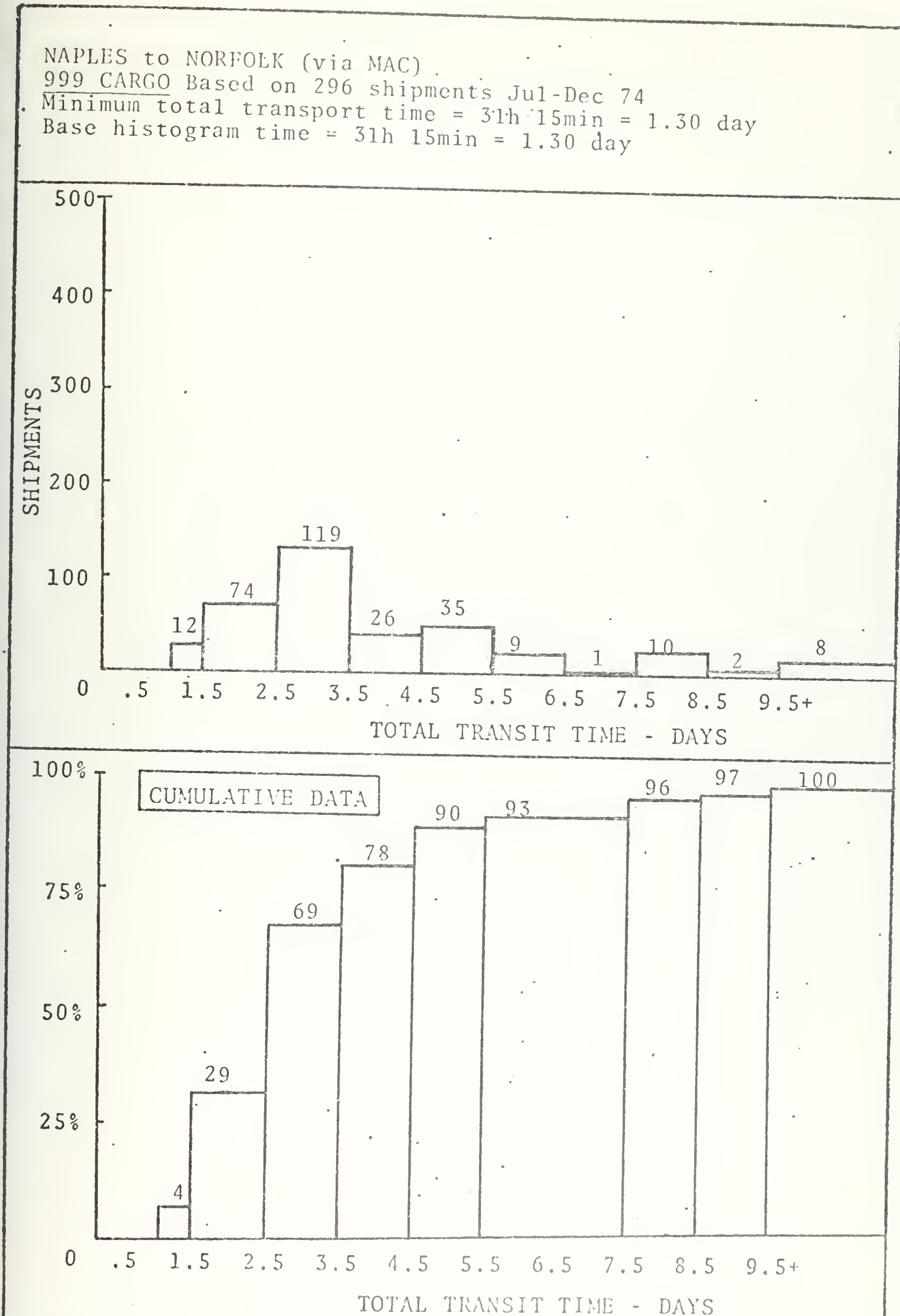

NAPLES to NORFOLK (via MAC)
999 CARGO Based on 296 shipments Jul-Dec 74
Minimum total transport time = 31h 15min = 1.30 day
Base histogram time = 31h 15min = 1.30 day
SHIPMENTS
500
400
300
200
100
0
12
74
119
26
35
9
1
10
2
8
.5
1.5
2.5
3.5
4.5
5.5
6.5
7.5
8.5
9.5+
TOTAL TRANSIT TIME - DAYS
CUMULATIVE DATA
100%
75%
50%
25%
0
4
29
69
78
90
93
96
97
100
.5
1.5
2.5
3.5
4.5
5.5
6.5
7.5
8.5
9.5+
TOTAL TRANSIT TIME - DAYS

FIGURE 70

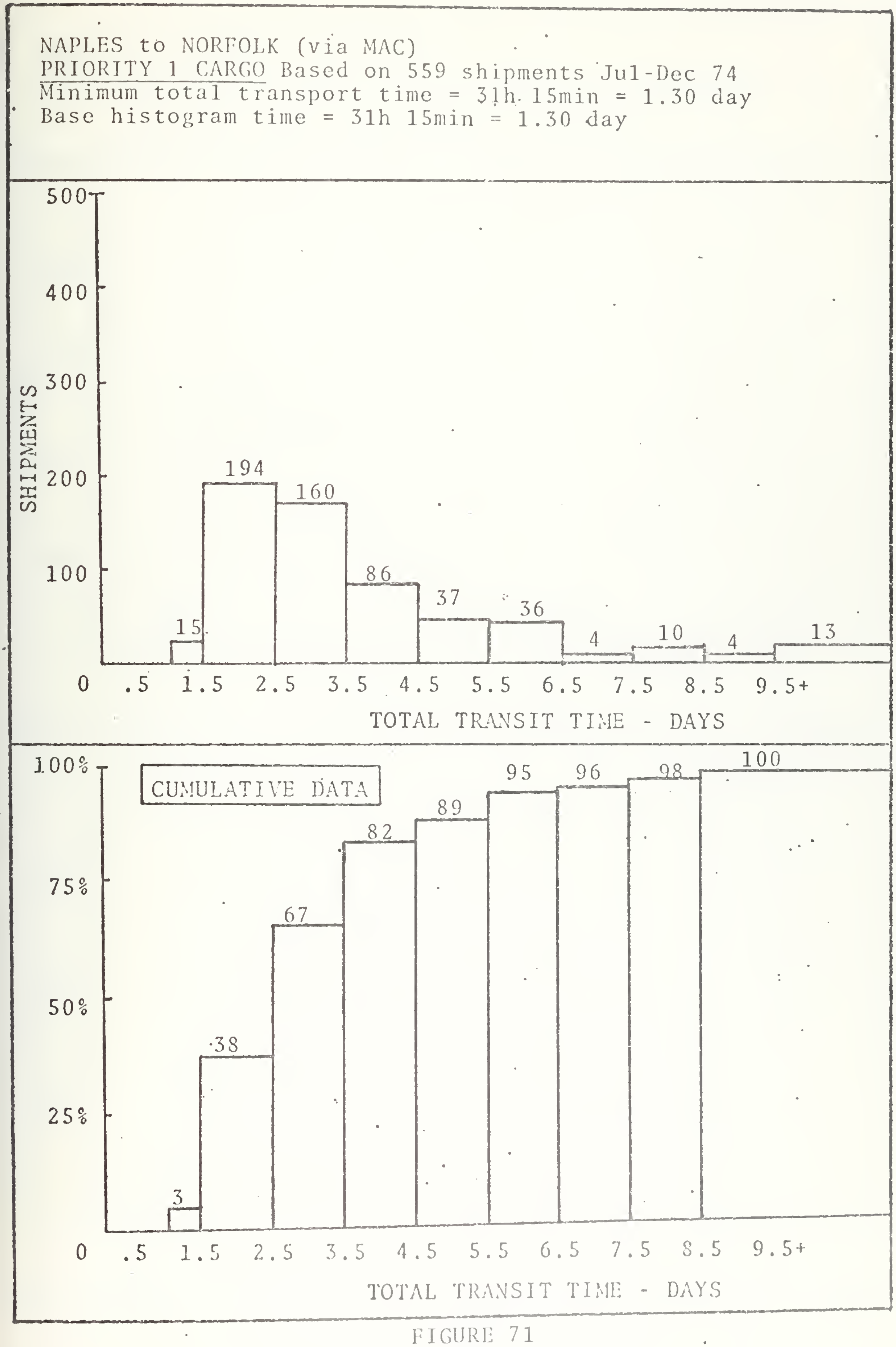

NAPLES to NORFOLK (via MAC)
PRIORITY 1 CARGO Based on 559 shipments Jul-Dec 74
Minimum total transport time = 31h 15min = 1.30 day
Base histogram time = 31h 15min = 1.30 day
SHIPMENTS
500
400
300
200
100
0
194
160
86
37
36
15
4
10
4
13
.5
1.5
2.5
3.5
4.5
5.5
6.5
7.5
8.5
9.5+
TOTAL TRANSIT TIME - DAYS
CUMULATIVE DATA
100%
75%
50%
25%
3
38
67
82
89
95
96
98
100
TOTAL TRANSIT TIME - DAYS

FIGURE 71

NAPLES to NORFOLK (via MAC)
PRIORITY 2 CARGO Based on 1566 shipments Jul-Dec 74
Minimum total transport time = 31h 15min = 1.30 day
Base histogram time = 31h 15min = 1.30 day

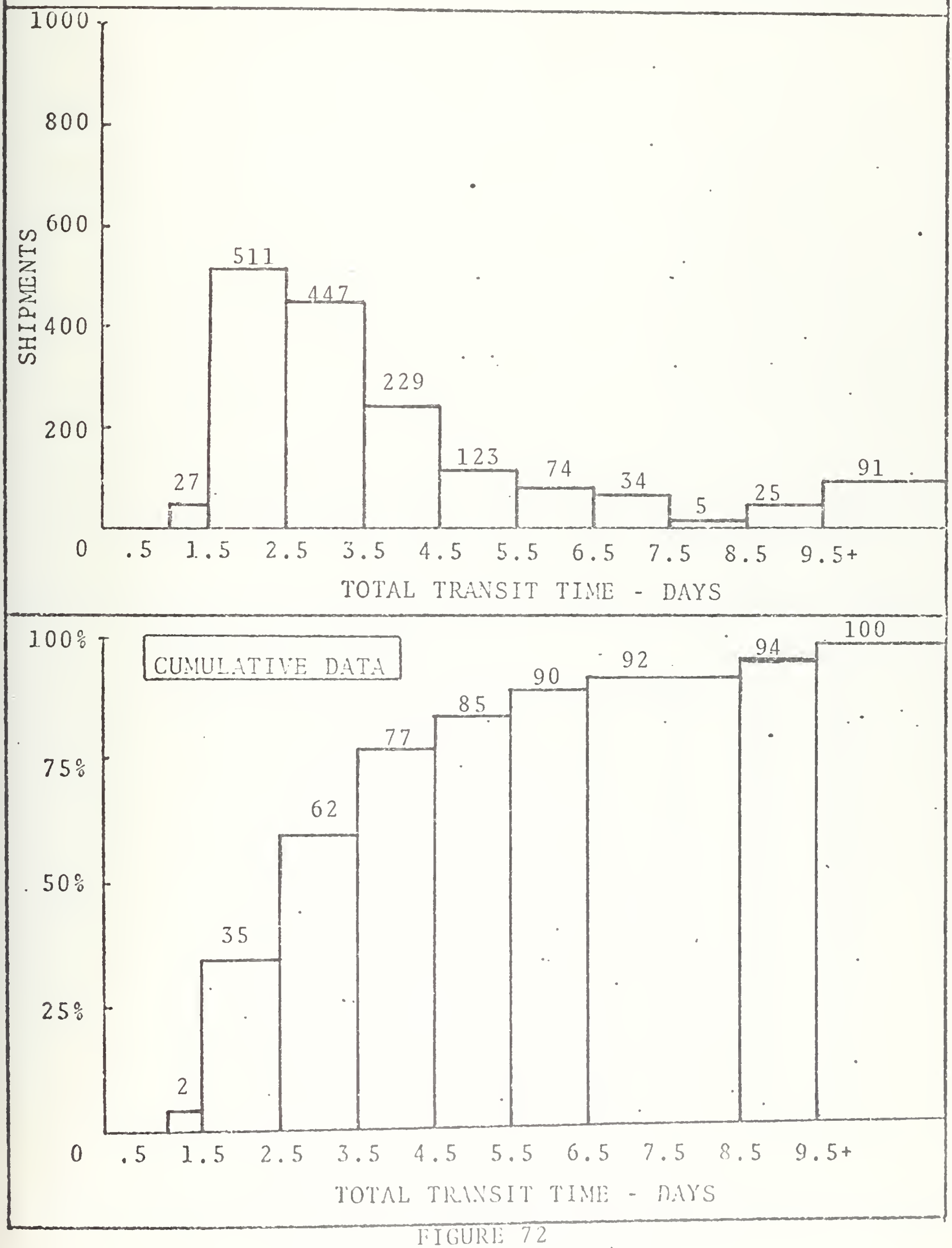


FIGURE 72

NAPLES to NORFOLK (via MAC)
PRIORITY 3 CARGO Based on 124 shipments Jul-Dec 74
Minimum total transport time = 31h 15min = 1.30 day
Base histogram time = 31h 15min = 1.30 day

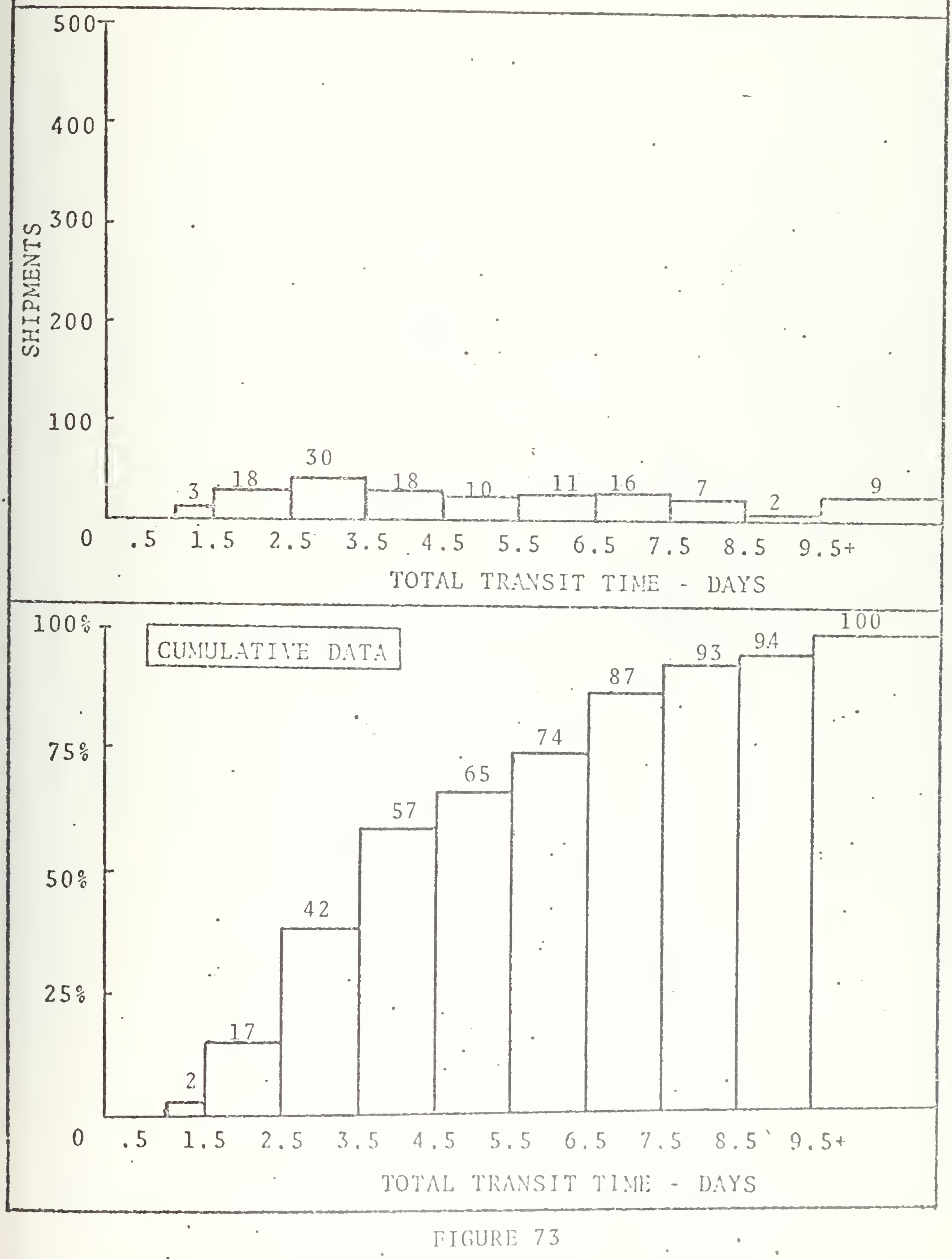


FIGURE 73

NORFOLK to CHARLESTON (via QUICKTRANS)

Minimum total transport time = 1h 30min = .06 day

NORFOLK to CHARLESTON	
Mean time	33h
Minimum time	7h

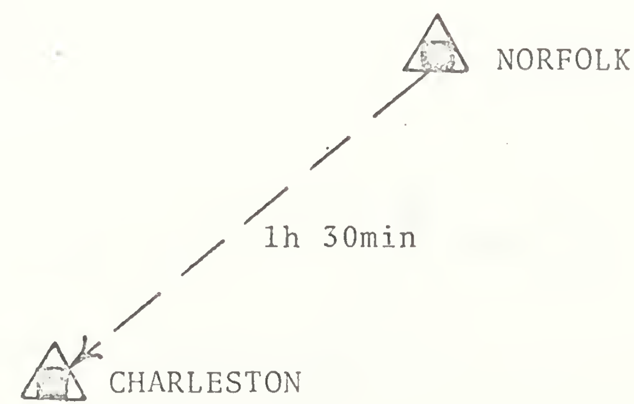


FIGURE 74

NORFOLK to JACKSONVILLE (via QUICKTRANS)

Minimum total transport time = 3h 30min = .15 day

NORFOLK to JACKSONVILLE	
Mean time	37h
Minimum time	9h

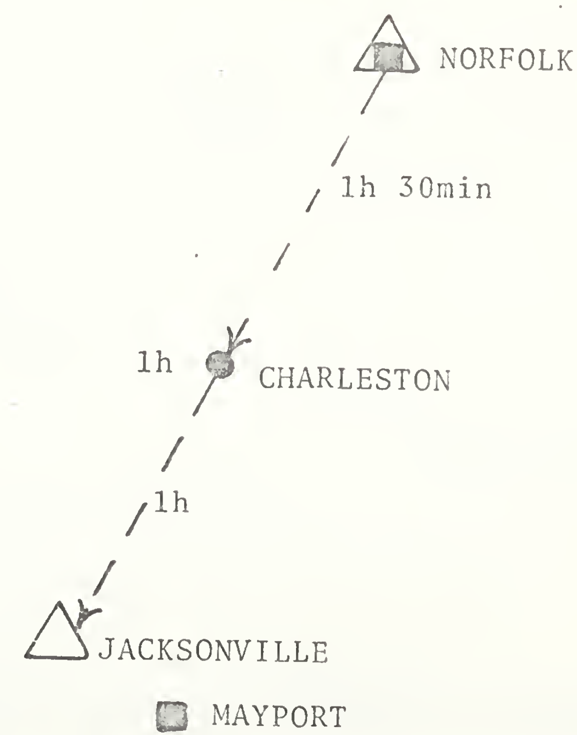


FIGURE 75

NORFOLK to LONG BEACH (via QUICKTRANS)

Minimum total transport time = 13h 35min = .57 day

NORFOLK to LONG BEACH
Mean time 98h
Minimum time 21h

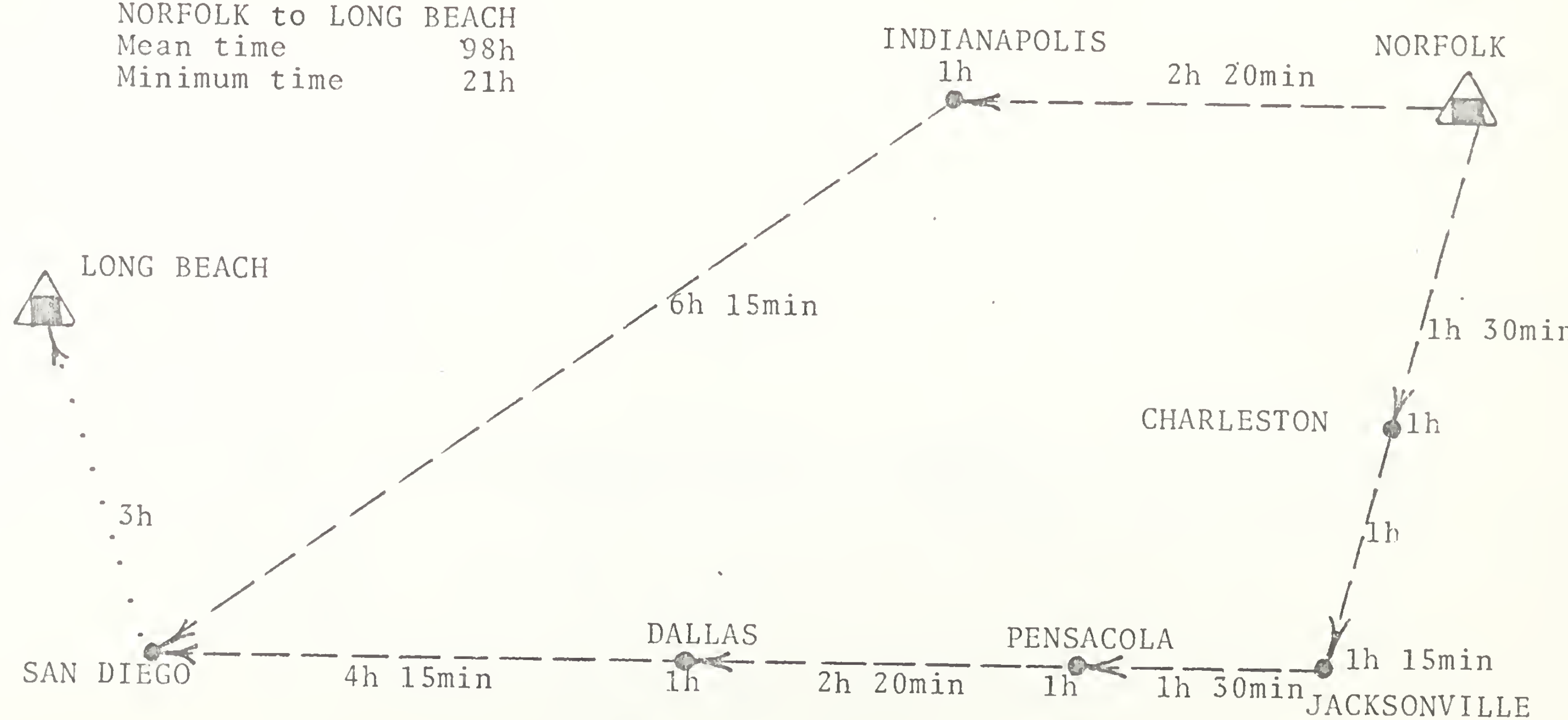
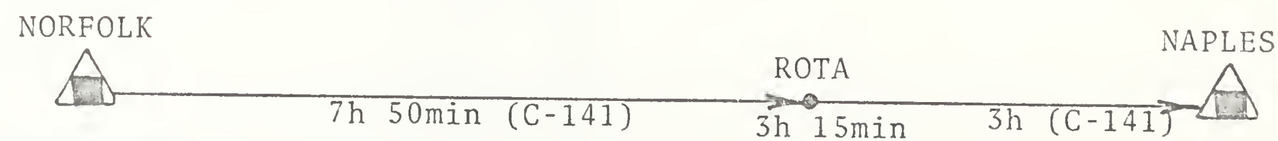


FIGURE 76

NORFOLK to NAPLES via MAC

Minimum total transport time = 14h 5min = .58 day
Base histogram time = 14h 5min = .58 day
(PRI-3 data sample not significant)



Mean PHT
999 36h
PRI-1 39h
PRI-2 71h

FIGURE 77

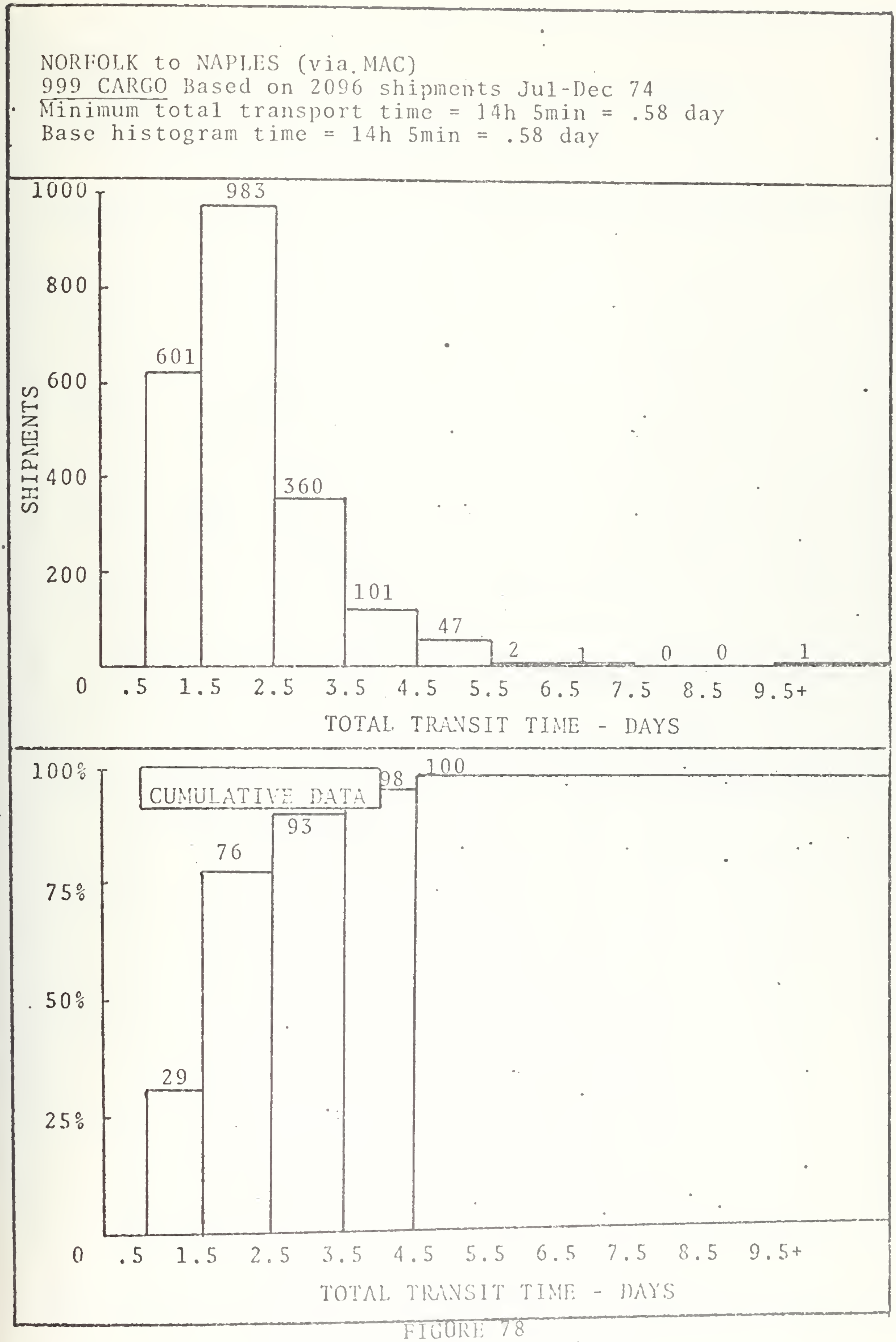
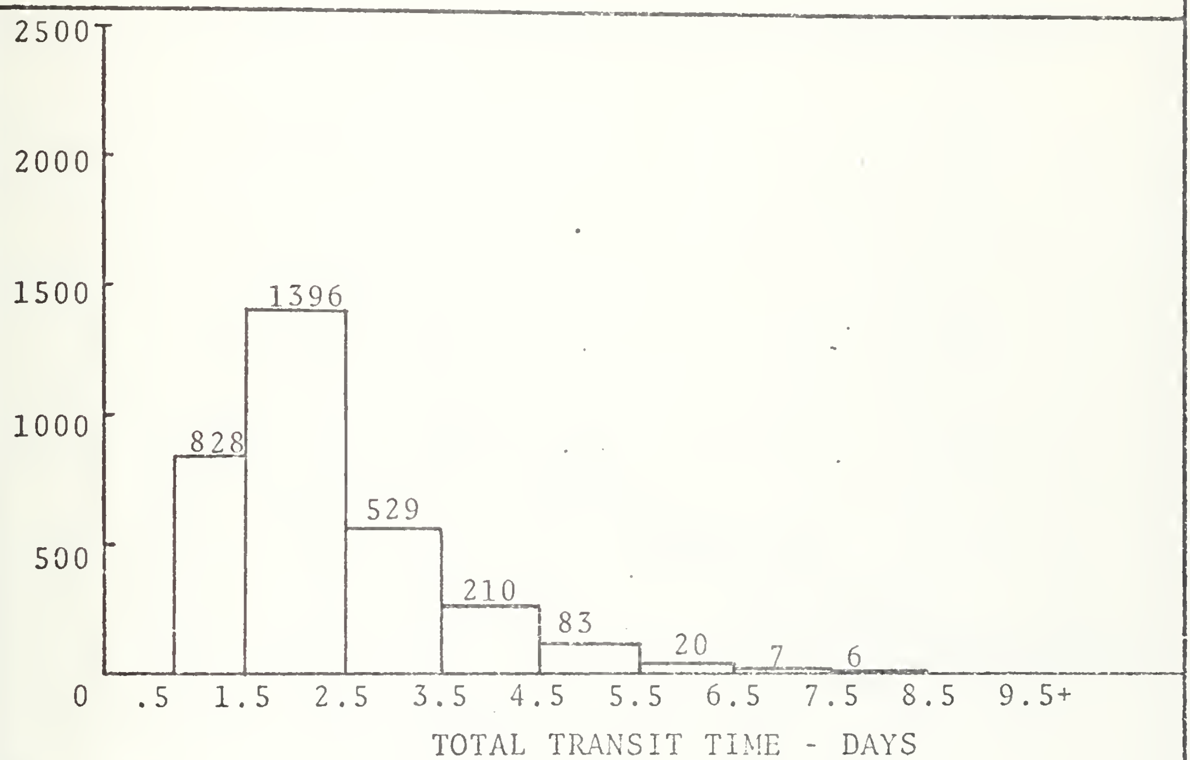

NORFOLK to NAPLES (via MAC)
999 CARGO Based on 2096 shipments Jul-Dec 74
Minimum total transport time = 14h 5min = .58 day
Base histogram time = 14h 5min = .58 day
SHIPMENTS
1000
800
600
400
200
0
601
983
360
101
47
2
1
0
0
1
.5
1.5
2.5
3.5
4.5
5.5
6.5
7.5
8.5
9.5+
TOTAL TRANSIT TIME - DAYS
CUMULATIVE DATA
100%
75%
50%
25%
29
76
93
98
100
TOTAL TRANSIT TIME - DAYS

FIGURE 78

NORFOLK to NAPLES (via MAC)
PRIORITY 1 CARGO Based on 3083 shipments Jul-Dec 74
Minimum total transport time = 14h 5min = .58 day
Base histogram time = 14h 5min = .58 day



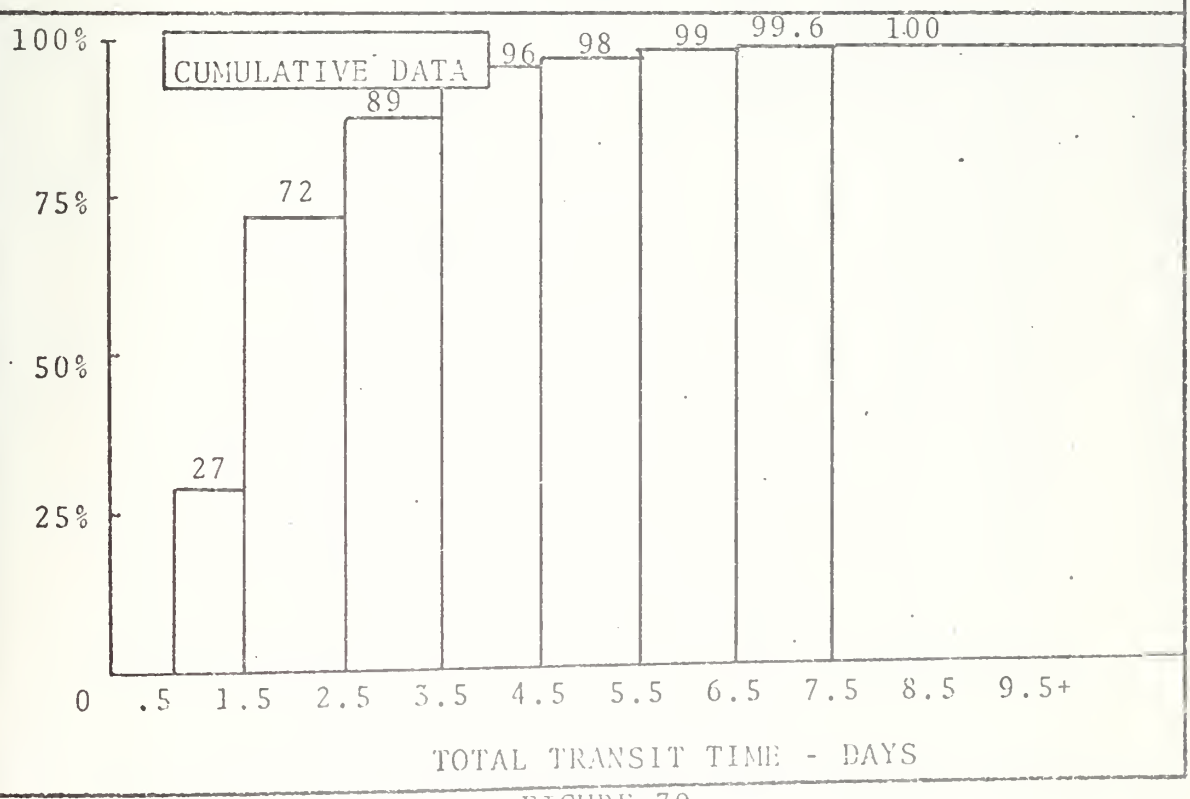


FIGURE 79

NORFOLK to NAPLES (via MAC)
PRIORITY 2 CARGO Based on 7603 shipments Jul-Dec 74
Minimum total transport time = 14h 5min = .58 day
Base histogram time = 14h 5min = .58 day

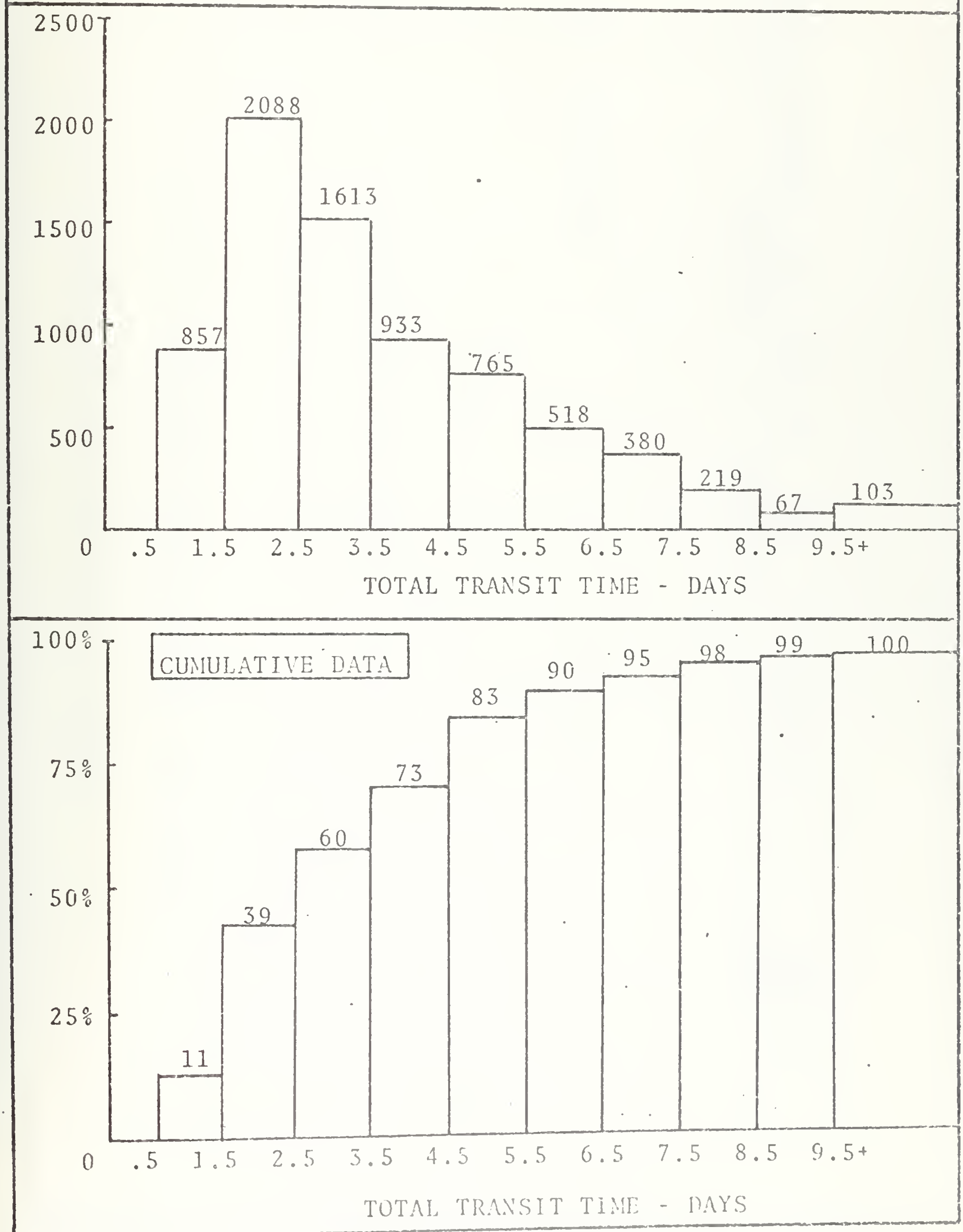


FIGURE 80

NORFOLK to SAN DIEGO (via QUICKTRANS)

Minimum total transport time = 9h 35min = .40 day

NORFOLK to SAN DIEGO	
Mean time	54h
Minimum time	16h

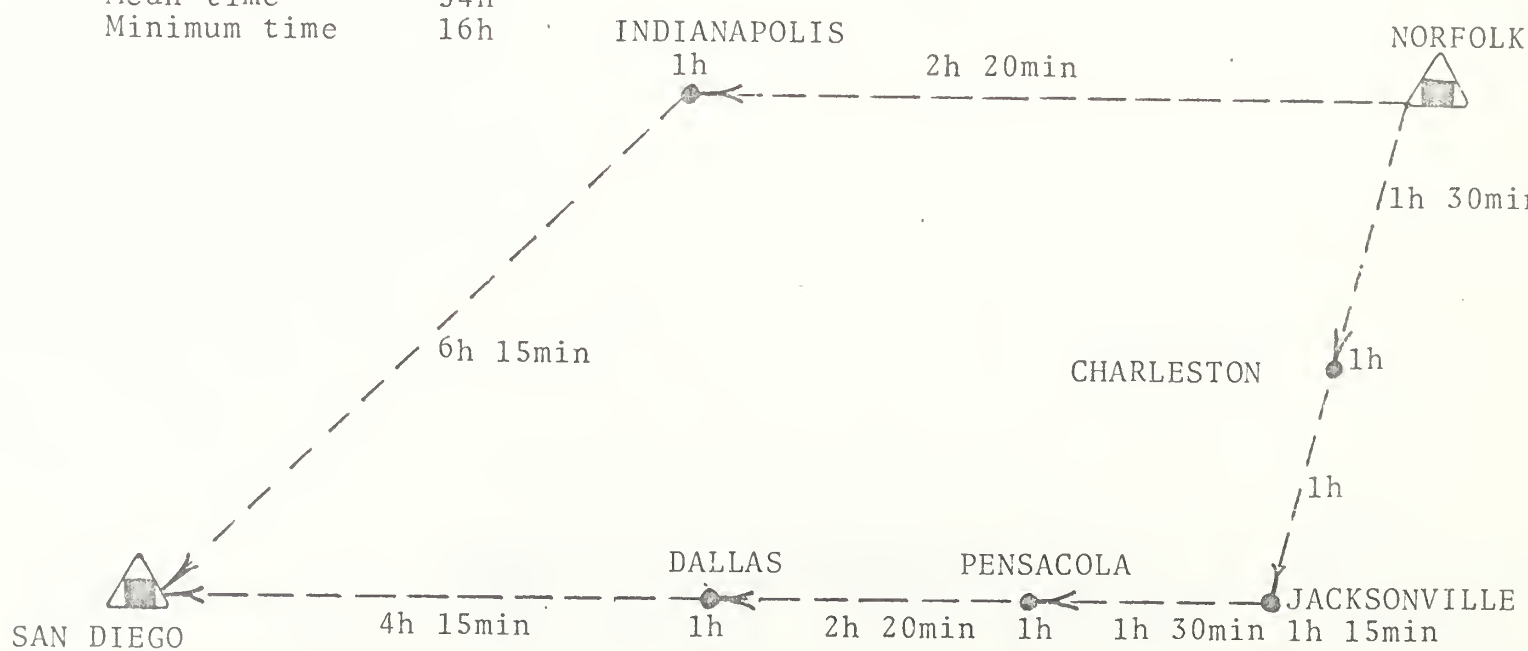


FIGURE 81

SAN DIEGO to NORFOLK (via QUICKTRANS)

Minimum total transport time = 7h 35min = .32 day

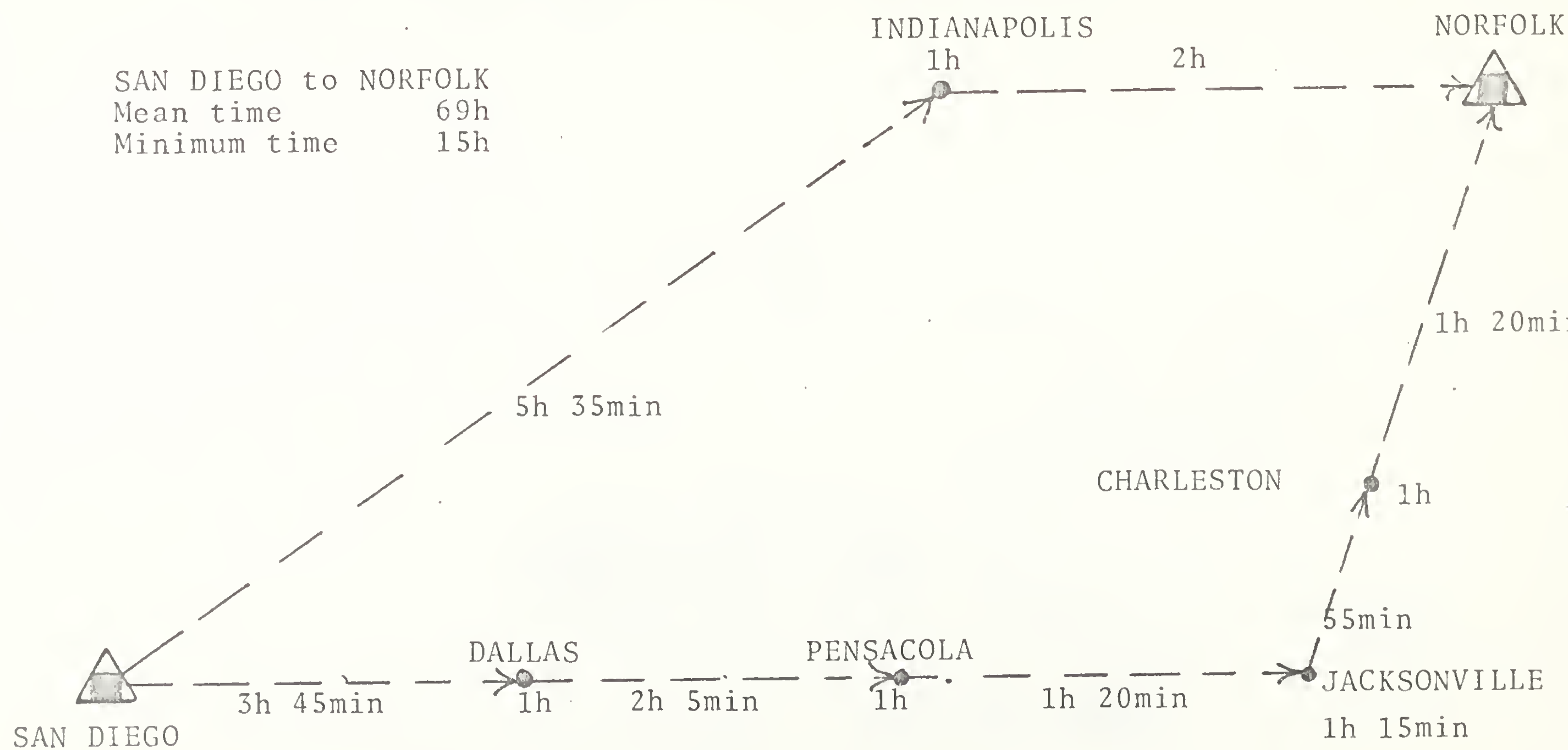


FIGURE 82

YOKOTA to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS)

Minimum total transport time = 9h 40min + 1h 50min + 3h = 14h 30min = .60 day
Base histogram time = 9h 40min + 62h = 71h 40min = 2.99 day
(PRI-3 data sample insufficient)

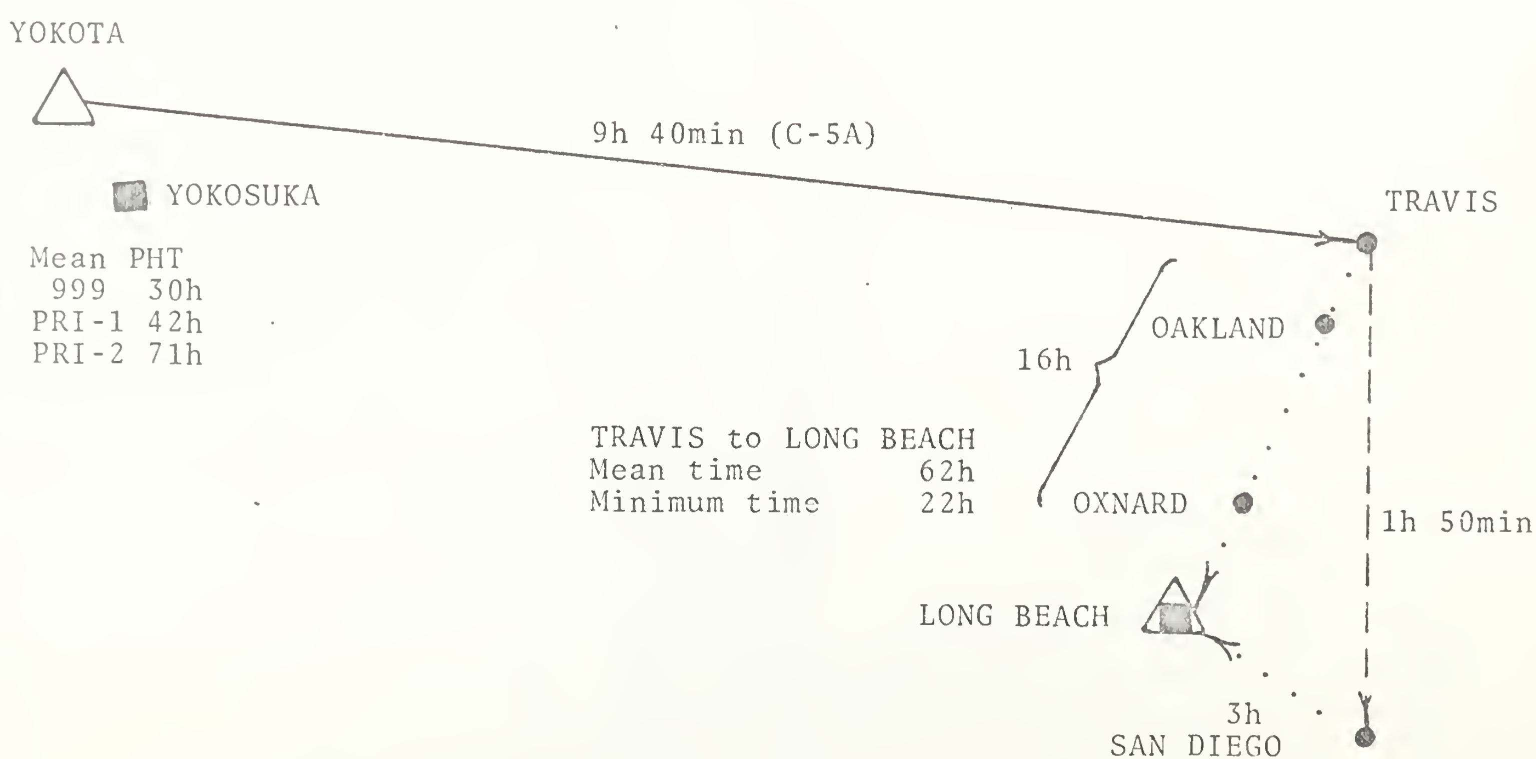


FIGURE 83

YOKOTA to TRAVIS (vía MAC) to SAN DIEGO (via QUICKTRANS)
999 CARGO Based on 152 shipments Jul-Dec 74
Minimum total transport time = 11h 30min = .48 day
Base histogram time = 27h 40min = 1.15 day

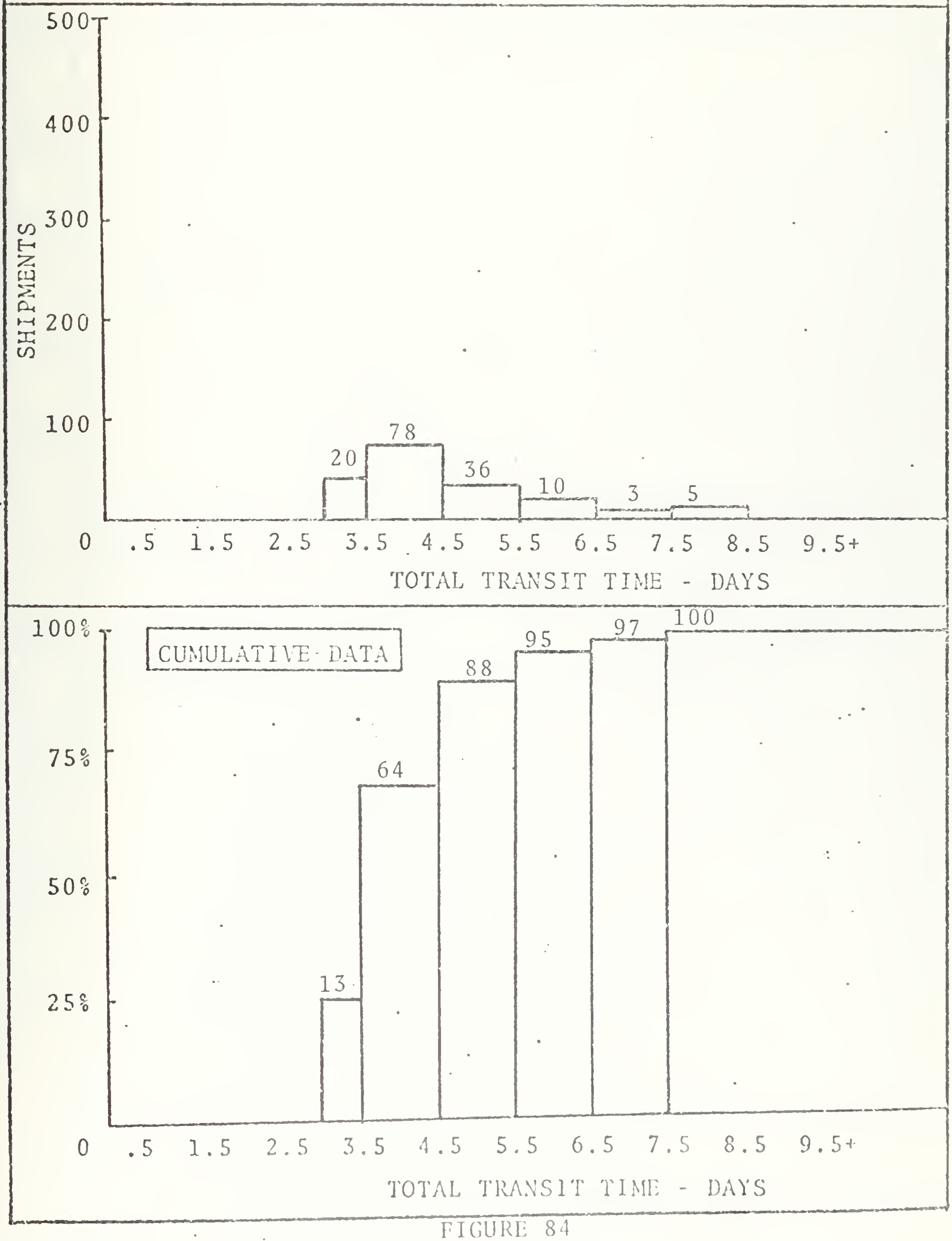


FIGURE 84

YOKOTA to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS)
PRIORITY 1 CARGO Based on 352 shipments Jul-Dec 74
Minimum total transport time = 14h 30min = .60 day
Base histogram time = 71h 40min = 2.99 day

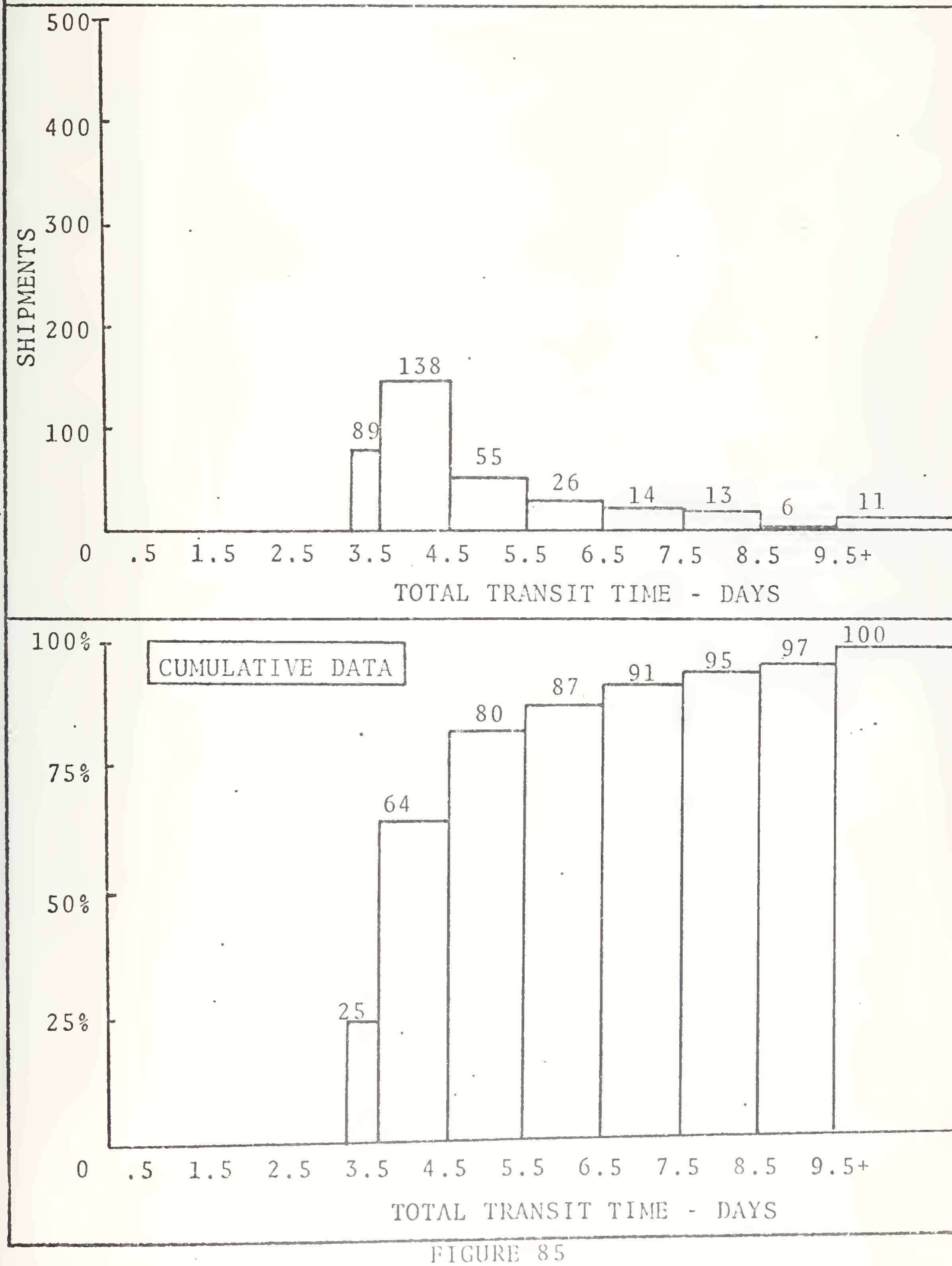
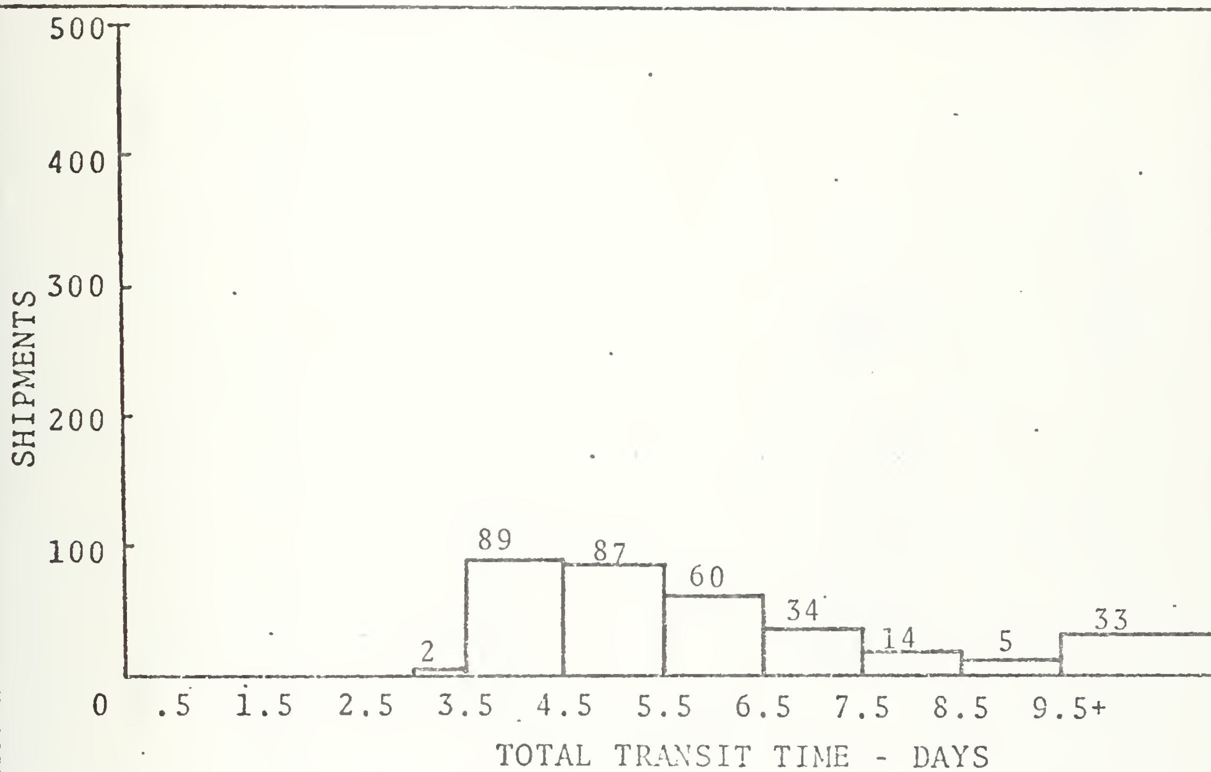


FIGURE 85

YOKOTA to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS)
PRIORITY 2 CARGO Based on 324 shipments Jul-Dec 74
Minimum total transport time = 14h 30min = .60 day
Base histogram time = 71h 40min = 2.99 day



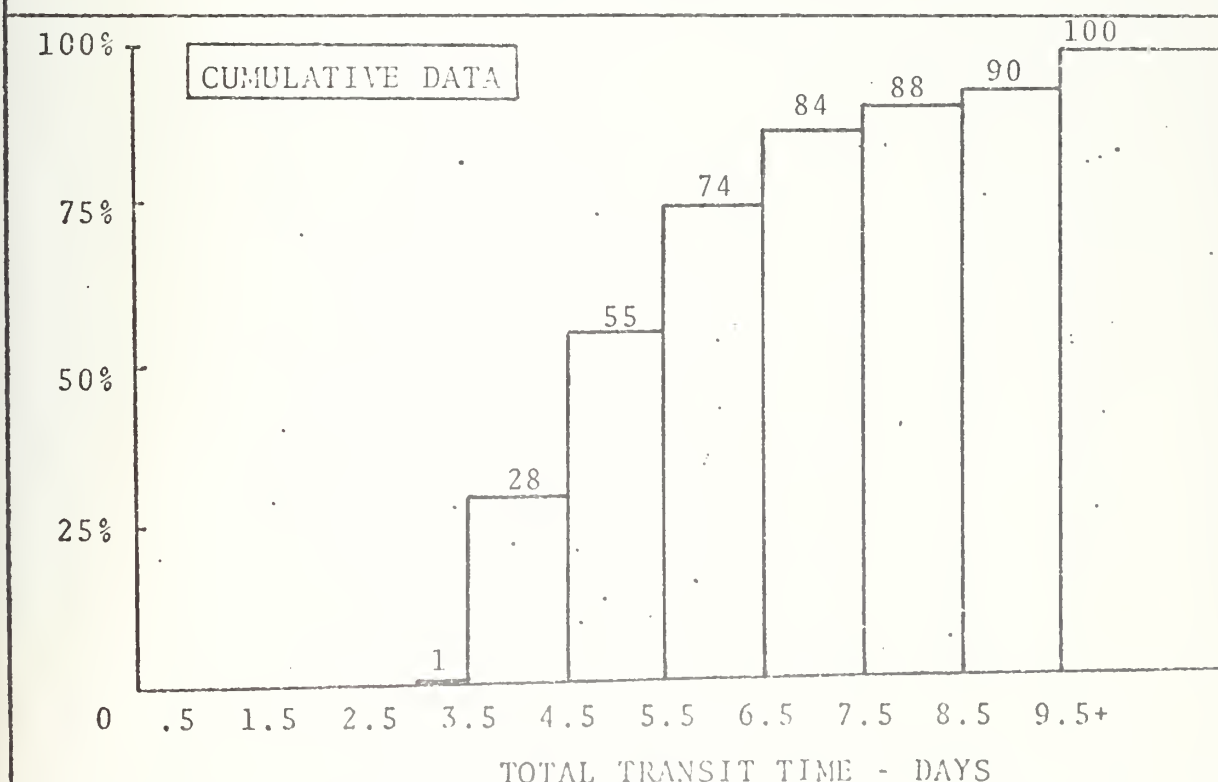


FIGURE 86

YOKOTA to TRAVIS (via MAC) to SAN DIEGO (via QUICKTRANS)

Minimum total transport time = 9h 40min + 1h 50min = 11h 30min = .48 day
Base histogram time = 9h 40min + 18h = 27h 40min = 1.15 day
(PRI-3 data sample insufficient)

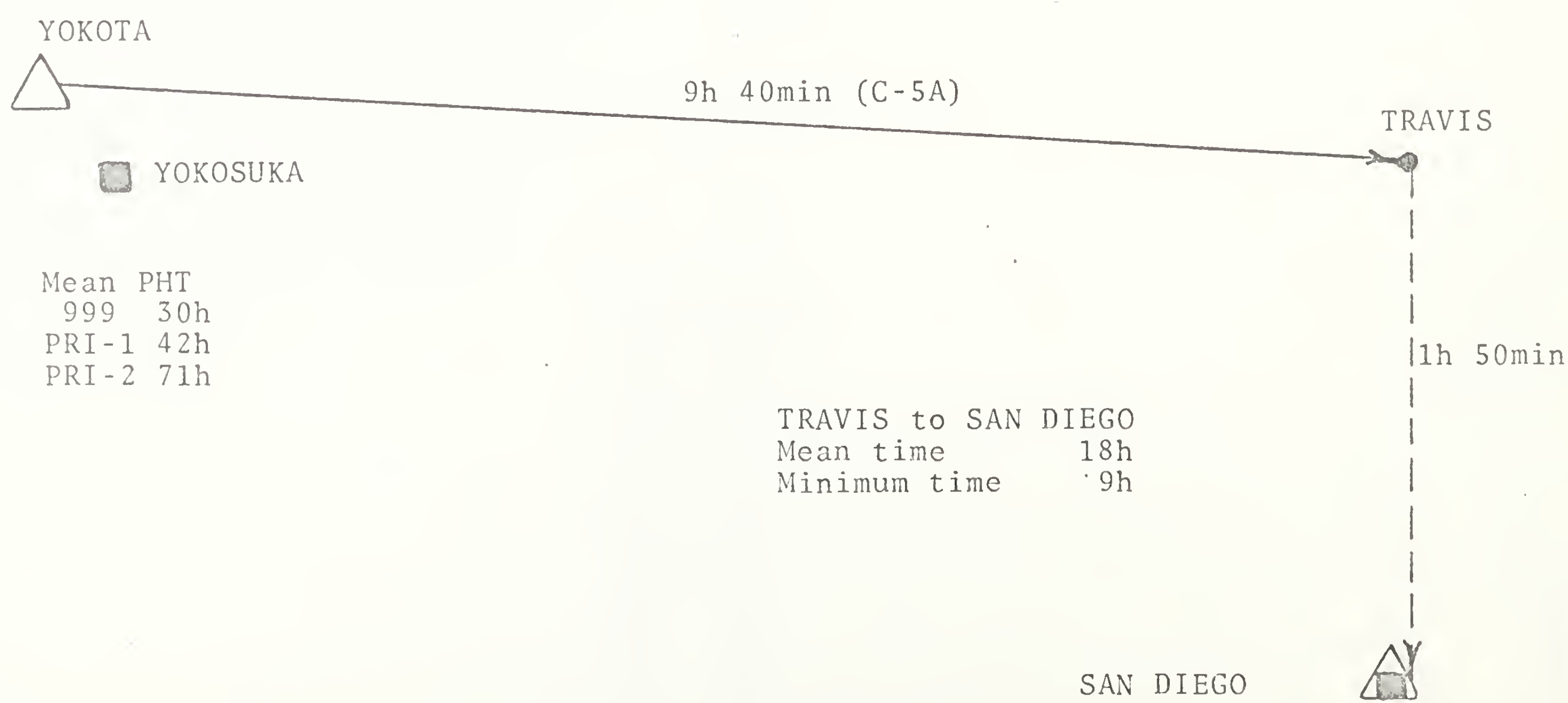


FIGURE 87

YOKOTA to TRAVIS (via MAC) to LONG BEACH (via QUICKTRANS)
999 CARGO Based on 152 shipments Jul-Dec 74
Minimum total transport time = 14h 30min = .60 day
Base histogram time = 71h 40min = 2.99 day

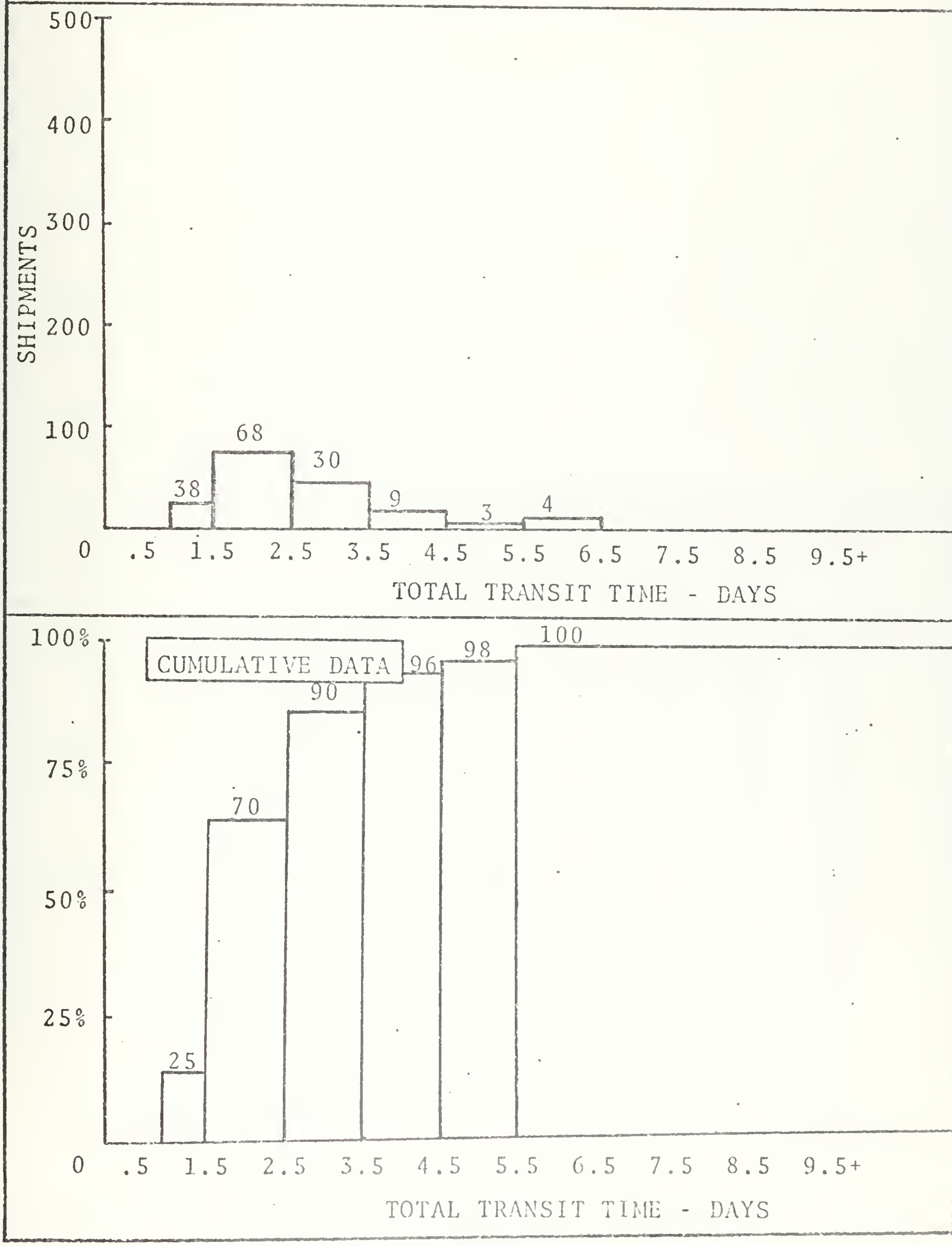


FIGURE 88

YOKOTA to TRAVIS (via MAC) to SAN DIEGO (via QUICKTRANS)
PRIORITY 1 CARGO Based on 352 shipments Jul-Dec 74
Minimum total transport time = 11h 30min = .48 day
Base histogram time = 27h 40min = 1.15 day

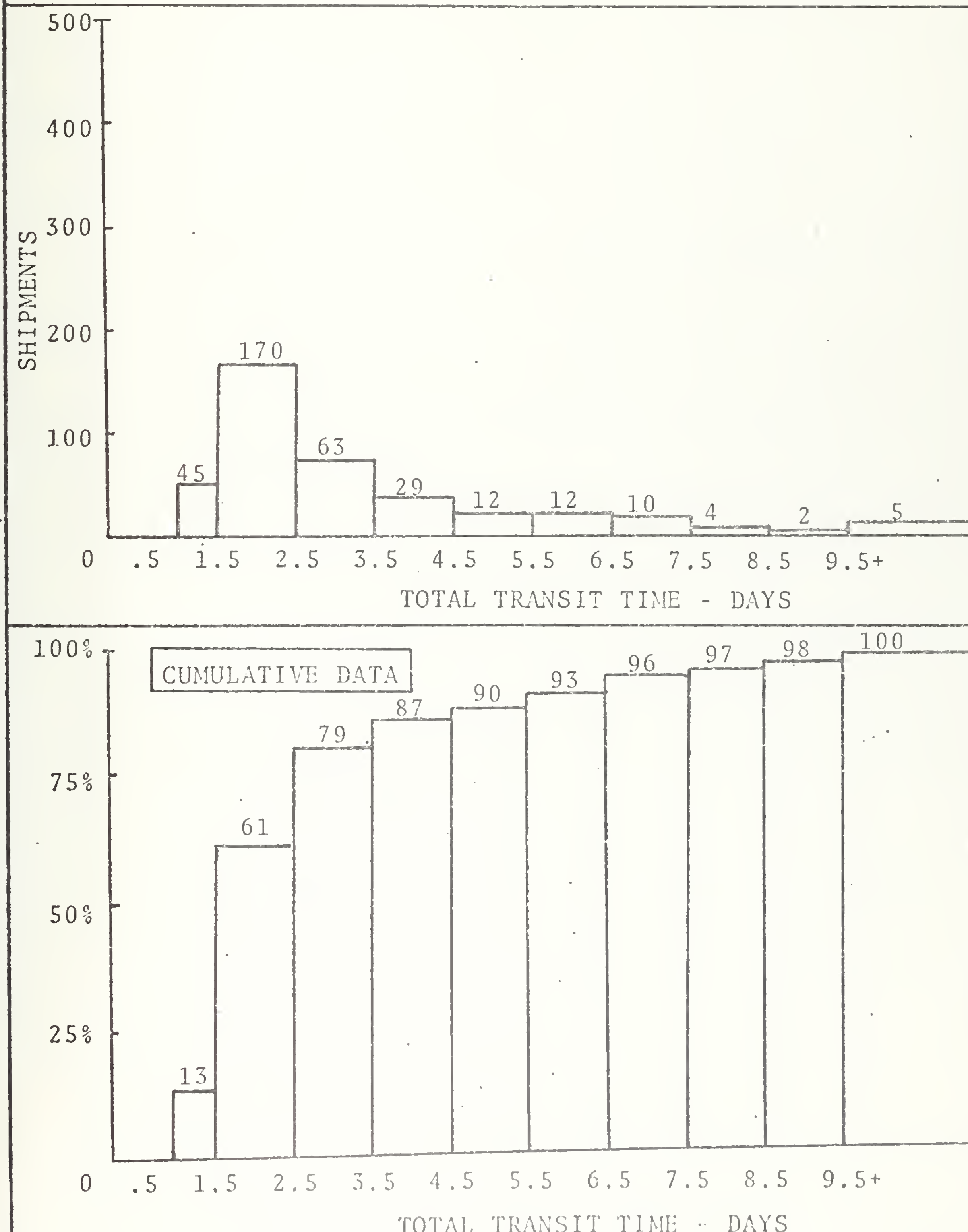


FIGURE 89

YOKOTA to TRAVIS (via MAC) to SAN DIEGO (via QUICKTRANS)
PRIORITY 2 CARGO Based on 324 shipments Jul-Dec 74
Minimum total transport time = 11h 30min = .48 day
Base histogram time = 27h 40min = 1.15 day

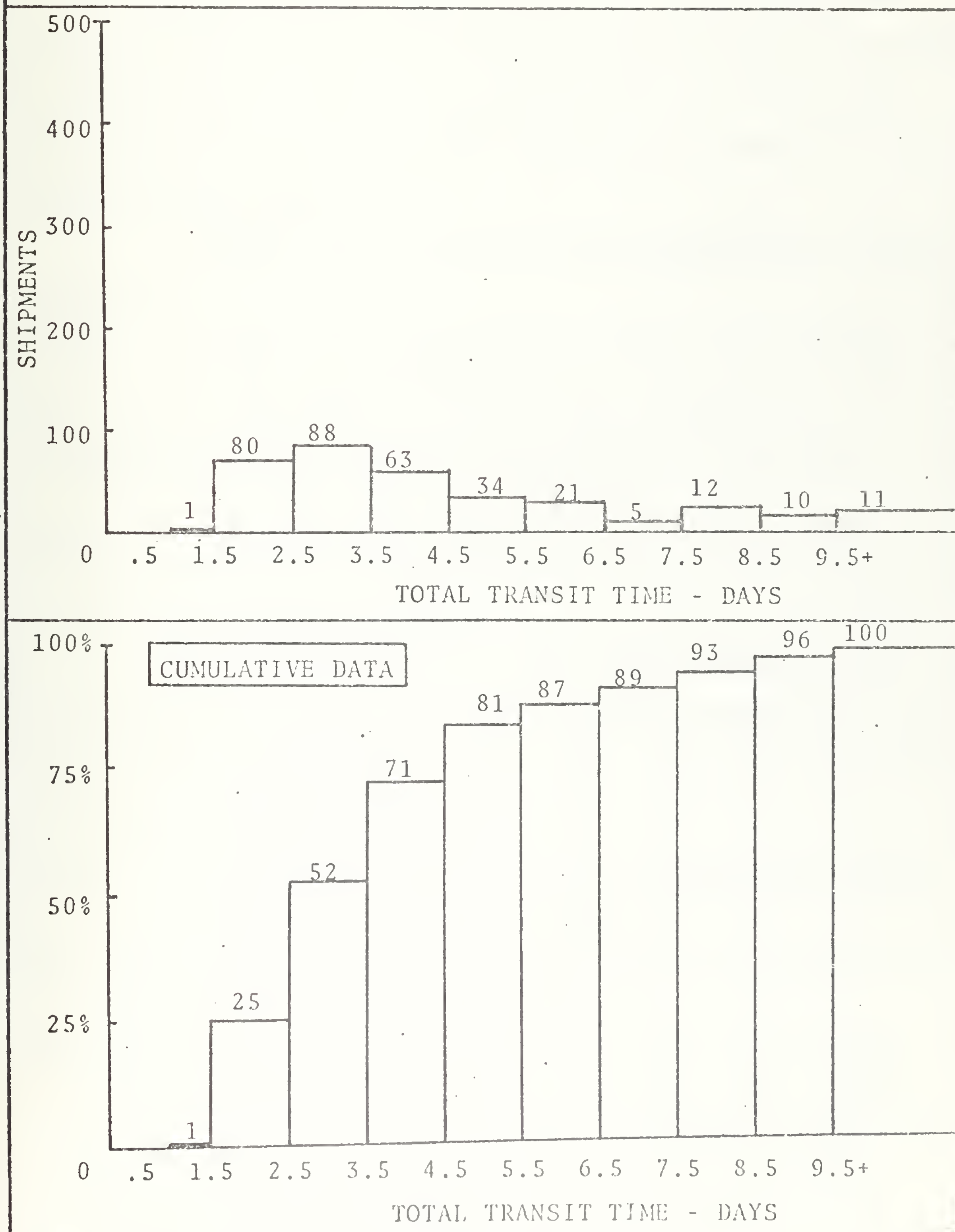


FIGURE 90

While the times for the major use legs were developed it was impossible to develop times for some others due to the complete lack of historic information. Therefore times from the primary stock points or IMA's to the ships and any others not given in the previous data that are deemed necessary will have to be an estimate based on the ships expected location. A minimum of one day is required by the model for all shipments.

The fields of data on the transportation record follow:

FROM	The point from which an item is to be shipped.
TO	The point which the item is shipped to.
TRANS DIST	The distribution information for the transportation times over the leg.
USE	Used by the program to accumulate the use data for later output.

6. Miscellaneous Record

The miscellaneous file (MISC FILE) contains one record of input data. This data is used internally by the computer to control phases of the run. The fields of information follow:

PCLT	The procurement lead time for new units. This is the time from order to arrival of the units at the primary stock points.
RUN PERIOD	The number of clock days that the program user desires to simulate.
MAX LOSSES	The maximum number of units that are allowed to be lost to the system before a procurement order is placed to replace them. The procurement order is placed automatically for the number of units lost and distributes them to the primary stock point on the coast where they were lost.

E PSP	East coast primary stock point.
W PSP	West coast primary stock point.

7. Internal Storage Words

In addition to the files of records there are several code words used in the program to designate storage spaces for certain information. These words and their use are as follows:

CLOCK	Used in the main program to keep track of the number of days run and the day the program is simulating.
TO CODE	Used throughout the program to designate the destination of a shipment for determination of the transportation time.
FROM CODE	Used throughout the program to designate the origin of a shipment for determination of the transportation time.
TURN-IN	Used in the failure routine to store the ship to point of an NRFI unit.
HOLD ITEM	Used in the failure and PMA routines to store an item number for future reference.
REPAIR STORE	Used in the failure routine to store the repair level of the NRFI unit for future reference.
HOLD TIME	Used in the failure routine to store a number indicating a future clock time for later comparison.
HOLD SITE 1 through 5	Used in the failure routine to hold site codes needed for future reference.
ORDER HOLD	Used in the backorder routine to hold the reorder code for future reference.
E LOSS	The cumulative storage of East Coast losses.
W LOSS	The cumulative storage of West Coast losses.
TOTAL LOSS	The cumulative total of both East and West Coast losses which is an output of the program.

TOTAL PROCURED	The cumulative total of all procurements printed as an output of the program.

E. ROUTINES

The following discussion is presented as a short explanation of the individual routines used in the program. It is not intended to be so complete as to replace the flowcharts presented in Appendix C, however when used in conjunction with them it should provide a thorough understanding of the manipulations carried out by the model. The routines and subroutines will be presented individually and connections between them will be pointed out. It is suggested that the flowcharts presented in Appendix C be referenced in conjunction with the reading of this section.

1. Main Program

The main program starts the run and inputs the data. It then generates a stack record, action coded FAILURE, for each unit installed on the ships. It considers the introduction data of each ship when computing the future failure date of the items and uses the fail time subroutine to determine the number of clock days each unit will operate.

The routine then adds one to the clock and accesses the first record in the event stack. With the event stack being input in chronological order and kept in order by the stacking procedures, if the first record is not due for action on the day indicated by the clock then no action is required on that particular day. If this is the case the program then branches to the closeout/print routine (C).

If action is indicated it will branch to the routine that is called for by the action code. The code could indicate either RFI DEL (D), FAILURE (E), PMA (F), BACKORDER (G), NRFI DEL (H), PROCUREMENT (I), or STOCK/PMS (J). When the action is complete the program will branch back to this routine again and look at the next stack record. When no further actions are necessary and the closeout/print routine is complete it will branch back and add one to the clock before accessing the stack records again.

2. RFI Delivery (D)

When the action called for on a stack record is RFI DEL the program branches to this routine. Its first action is to access the site or ship record which is to be the destination of the delivery. If the destination is a site it will add 1 to the site inventory and check to see if the inventory level is over the maximum allowed. If it is, the unit is shipped to the sites ORDER FROM 1 point. If the maximum is not exceeded the unit is kept and in either case a check is made to see if the site itself repaired the unit and if so one is added to REPAIRED to keep track of the number repaired at each site.

If the destination is a ship the unit will be added to the ships inventory unless it is missing an installed unit (NORS). If it is NORS then the unit is installed and a record is generated for its pending failure.

3. Failure (E)

When the action called for is FAILURE the routine first accesses the ship record for the ship on which the

unit was installed. It adds one to the ships failures and generates a stack record for the shipment of the NRFI unit (NRFI DEL). At this point it also determines the level at which the unit will be repaired or if it is lost. If the unit is lost it is added to East or West Coast losses as appropriate.

The program then goes through the manipulations necessary to provide a replacement unit. First it screens the ships inventory and if a unit is available it is installed and a stack record for the pending failure is generated. The IG-2/3 ORDER FROM site is then screened for a unit to replace the inventory item used. If the site has no RFI inventory then the unit is backordered.

If the ship had no units in stock the next check is to see if an AFS is available and if it has a RFI unit. If so the unit is shipped from the AFS, probably a time of one day, and the ship is put in a NORS condition until it arrives. The AFS will also order a replacement unit for its stock from the ORDER FROM 1 point or will backorder if none are available. If no AFS is desired as a stock point then a zero code will appear in AFS on the ship record.

If no AFS is available it will next screen the IG-1 ORDER FROM site for a replacement part. If available, the unit will be sent with the ship being NORS during the transit period. If no unit is available at this site the event stack will be checked for the next scheduled RFI delivery to be received by it. Through a series of comparisons the program will see if a unit could be obtained

sooner from one of this sites ORDER FROM 1 through 4 points, than waiting for the scheduled delivery to the site plus transportation time to the ship. If no unit can be obtained sooner from these sites the unit will be backordered from the IG-1 ORDER FROM SITE. If a unit is supplied from any one of the sites, that site will order or backorder to replace its inventory unless it is a primary stock point which can be replenished only from repair or procurement. If it is determined that the site which supplied the unit will also repair the failed unit the routine will not order a replacement but will rely upon the repair for inventory replenishment.

4. Programmed Maintenance Action (F)

If the action called for is PMA the model branches to this routine. The site record for the destination and the ship record matching the INSTALL CODE are first accessed. If the ship is missing an item (NORS) the program will search through the stack for the backordered unit or the DELIVERY coded record which indicates the action being taken on the missing unit. If a unit is backordered the record is cancelled and the available unit is installed with the appropriate failure record initiated. If a unit is in transit (coded DELIVERY) it is turned around to return to the point of origin with two days added for locating the unit and completing the turnaround.

If the ship is not NORS then the routine will find the FAILURE coded record for the item to be replaced. The time since the unit was installed is computed to determine

if its time installed exceeds the MIN OPS TIME. If not the programmed maintenance replacement unit is returned to its site of origin and no changeout takes place. If the time is exceeded the new unit is installed and the removed unit is shipped to the sites ORDER FROM 1 point for repair.

5. Backorder (G)

An action code of BACKORDER calls for the following action. The site record for the site from which the unit is backordered (ORIGIN CODE) is accessed and checked for inventory. If none is available BACKORDER is increased by one and the stack code is increased by one so that it will be checked again the next clock day.

If the site has RFI inventory the transit time is computed and a record coded RFI DEL is generated. DEMANDS is increased by one and if the BACKORDER coded stack record was coded for a reorder, and the site is not a primary stock point, a unit is ordered or backordered to replace the sites stock.

6. NRFI Delivery (H)

For stack records coded NRFI DEL the program branches to this routine. After locating the appropriate site record a check is made to see if the repair is to be made at this sites repair level and if the site has the capability. If not the unit is shipped on to the BCM TO point for repair. If it is to be repaired at this site it is added to the NRFI INV and a repair time is computed. A stack record is then generated for the time it will come out of repair coded RFI DEL.

7. Procurement (I)

When a stack record coded Procurement is encountered the following actions are taken. A stack record for each unit to be procured is initiated with a stack code equal to the CLOCK plus the procurement lead time (PCLT). This will become the delivery date on the new units.

8. Stock/Programmed Maintenance (J)

STOCK/PMS coded records cause the program to branch to this routine. The routine first checks the origin site to see if it has any RFI inventory. If it does not, the stack code is increased by one and one is added to the sites BACKORDER. If a unit is available it is shipped to the site or ship called for by the DEST CODE. The action code on the record will be either RFI DEL or PMA in the case of records with a ship code entered in the INSTALL CODE field.

9. Time Compare Subroutine

This subroutine is used by the failure routine to compare the delivery dates on units in stock at various sites against the expected delivery date on a unit which is in transit to the ships IG-1 ORDER FROM site and must then be forwarded to the ship. If the time for the unit in stock is shorter the program branches back to a point in the failure routine which orders the unit. If it is not, then the routine exits back to its previous location in the failure routine.

10. Transportation Subroutine

This subroutine accesses the distribution information for the transportation leg of interest and a random

digit. Whether the random digits will be computed and stored until used or computed at the time of use is left to the programmer. In either case subroutines are available as well as the routine necessary to compute a transit time from the cumulative distribution information and the random digit. This routine also adds one to the USE field of the record. It should be noted at this time that while this flowchart uses records for the transportation legs, a table look up arrangement would probably prove much more efficient. In the interest of simplicity and because of the differences in computer languages and computers themselves this problem is left to the programmer. It is believed that this does not significantly detract from the basic decision rules which this model attempts to present.

11. Fail Time Subroutine

This subroutine accesses the FAIL TIME DIST information and a random digit. From this point on the computations could be handled by the same routine as used in the transportation subroutine.

12. Repair Level Subroutine

This subroutine is basically the same as the two previous ones and would use the same routine for the computations.

13. Closeout/Print (C)

When all the actions necessary on the stack records for a given day are completed the program branches to this routine. The routine's first actions are to accumulate the

data on the site and ship records for future output. Next it determines if the total unit losses have equalled or exceeded MAX LOSSES. If so a procurement order is initiated for each coast. If not the routine determines if the end of a year has been reached. The year end triggers the print commands. For each site record it prints SITE CODE, BACKORDER, SUM RFI, SUM NRFI, DEMANDS, and REPAIRED. For each ship record it prints FROM, TO, and USE. It also prints TOTAL LOSS and TOTAL PROCURED. All of these values represent cumulative totals for the year and are computed to zero for the start of the next year's run.

The next check is for the end of the RUN PERIOD which will stop the routine. If this is not the case then it branches back to the main program.

F. OUTPUTS

The previous section gave a list of the items that are printed and the section prior to that gave an explanation of the code words. This section attempts to explain the reasoning behind selecting these particular outputs.

For each site the outputs were chosen to afford the user the opportunity to monitor the effectiveness of the site as well as those necessary to apply cost data if desired. The BACKORDER output gives the number of days that a demand was placed on the site which it could not fill. A high number would indicate too low an inventory, transportation delays too long, or repair time too long. The policies could then be changed in an attempt to lower the number. The SUM RFI

and SUM NRFI when divided by the number of days the site was in operation gives the average inventory. This may be looked at for high or low trends, however it was mainly kept so that in the event an attempt is made to apply costs to the system the cost of holding inventories could easily be applied. DEMANDS gives the cumulative number of demands filled and provides an indication of site usage. REPAIRED provides the number repaired at the site and can be utilized for both usage and cost applications.

The ship data probably gives the best idea of the effectiveness of the total system. SUM NORS indicates the total days each ship did without an installed item. If it is higher than is considered acceptable then some means of supplying the item on a more timely basis must be provided. This could be done through more onboard inventory, better use of the AFS, faster transportation, or maybe more stock at points close to the ship. The FAILURES output is designed primarily to monitor the simulation to make sure that one ship did not have an inordinate number of failures due to the random digit program.

The USE data for the transportation legs is for cost computations but might also show where heavy usage justifies more frequent flights or other improvements.

The TOTAL LOSS output gives an idea of what can be expected in the actual system and also allows simulation monitoring. The TOTAL PROCUREMENT is for cost data but is a good indication of the cost effectiveness of the operating

policies. If procurement can be cut significantly, with little loss in effectiveness, through inexpensive policy changes then they are probably justified.

G. APPLICATIONS

By making as many parameters as possible inputs rather than integral parts of the program the model gains a great deal of flexibility. Having successive runs for each item and varying only a few of the inputs per run can provide a good insight into the sensitivities of the system.

At the present time plans are to conduct all component repair at one or possibly two sites and not to stock units at the IMA's or on the AFS's. The program can be run this way by merely inputing the data in this form. If sometime in the future, changes to these policies present viable alternatives, the model is already equipped to handle it. This was done because it was the opinion of the authors that some of these changes will become necessary in order to provide a high degree of operational readiness through repairable item availability.

The model is especially useful in addressing such questions as:

1. What happens to the system's cost and effectiveness if stock points are added or taken away?
2. What happens to the system's cost and effectiveness if higher priority (Faster) transportation is utilized?

3. What if repair times or procurement times are cut significantly?
4. What if stocking levels are altered significantly?
5. What if site repair capabilities are changed?
6. What does a change in operating schedules or the number of ships do to the need for spare parts?

While the model does not provide optimum policies for the system it does afford the opportunity to test them in a very close approximation of the real world and to assess their worth. This model is meant to be used throughout the life of the LO-MIX ships and not just in the planning stages. As previously mentioned, if properly input into a computer, the results of the monitoring system will provide information of increasing accuracy for the model. The better these inputs the more realistic will be the output.

VII. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The repairable inventory distribution and monitoring system, as presented, is considered a viable and economically feasible tool for controlling and monitoring the repairable material associated with the PHM/FFG program. This system can provide both the actual physical support for these ships as well as the information required to effectively monitor the status and location of repairable material within the pipeline. As designed, the overall system is completely compatible with the present Navy Supply System and particular attention has been devoted to the utilization of existing resources and to avoid duplication of efforts.

Transportation pipeline data has been included to provide a basis for determining in-transit time frames which can be used to formulate follow-up and activity performance measurement criteria. This information will also be used in the repairable simulation model until actual program data from the monitoring system becomes available.

To complete the system, the repairables simulation model has been developed. This model, utilizing input data from the distribution/monitoring system and realistic in-transit time frames, will provide valuable information in determining inventory levels, repair policies, facility locations, procurement quantities and shipping/handling policies.

Herein lies the potential answers to the repairable asset management problems that may be associated with the

new LO-MIX concept. Even more critical, this system will provide the inventory manager the basic tool necessary for the optimum support of the PHM/FFG weapon system. Only with complete control of all system's stocks can the inventory manager make logical issue and repair decisions that will insure the maximum utilization of the available material. Positive control and up-to-date knowledge of stock levels and locations will also provide the inventory manager with the capability to effectively evaluate the degree of support effectiveness that could be expected.

Feedback accumulated from the monitoring system will provide the inventory manager the current data required to effectively track all Not Ready For Issue carcasses through the repair cycle and complete Ready for Issue asset visibility at all stock points. New avenues will be open to the inventory manager that will identify responsibility at all echelons and the means to initiate follow-up action as required.

Underlying these examples of the overall system as a tool to management is the repairables simulation model with the explicit capability to be able to react to changing conditions. The model can be used to simulate outcomes from variable input data and will provide the inventory manager with the data necessary to position material resources to meet the support requirements of the operating forces.

B. RECOMMENDATIONS

While the existing supply system and available transportation provides adequate support for the proposed LO-MIX repairables system in almost all cases, there are some areas where improvements could be made. The following are suggestions offered by the authors which should contribute significantly to the overall effectiveness of the system.

(1) Expedite development of the Mechanized Master Repairables Item List. The Mechanized MRIL should be compatible with the Uniform Automated Data Processing System (UADPS) and installed at all major stock points. This action will enable the stock points to rapidly transmit management data to the inventory manager and will provide the capability to automatically screen and ship Not Ready For Issue repairable material.

(2) Require a one-time inventory of all condition coded assets that are maintained on the Inventory Control Point stock records. This inventory report should include individual serial numbers for all repairable material held at the various stock point locations and designated overhaul points (Navy and commercial). The information gathered can be used to compare on-hand balances and the differences reconciled. Future reconciliations (inventory will not be required) should be conducted annually to verify the accuracy of stock records at the Inventory Control Point.

(3) In conjunction with the one-time inventory described above, all activities should be required to include

item serial numbers on all repairable material transactions reported to the Inventory Control Point. Serial number control will provide the capability to manage each asset as an entity and facilitate carcass tracking.

(4) A Fleet Repairables Assistance Agent (FRAA) should also be positioned at TRAVIS AFB and CLARK AFB to expedite the movement of retrograde NRFI repairable carcasses. Both TRAVIS and CLARK are key transshipment points to and from the western Theater of Operations.

(5) Set up the computer software necessary to input the information gained from the monitoring system into a central computer and to extract it in the form to be utilized by the repairables simulation. This should be done as soon as possible in order to build a timely and useful data base.

(6) Program the model presented in this thesis as soon as possible and start preliminary computer runs for planning purposes. Proper use of the model can prevent costly mistakes in setting up the system and could prove invaluable in the planning process as well as the operating phase.

(7) Where not already established, dedicated feeder lines into the MAC and QUICKTRANS systems should be established to minimize port hold times at the terminals.

(8) Similar dedicated systems should be established for timely notification and movement of goods at destination to minimize cargo hold time.

(9) Accumulate more detailed QUICKTRANS performance data (i.e., transportation and port hold time information by priority for specific routes and terminals) to enable the system to quantitatively evaluate channel performance.

APPENDIX A

The following is a comparison - breakdown between the DEG-1 Class Ship's Manning Document, OPNAV 10-P60 dtd 2 June 1971, and the PF Ship's Manning Document NAVSHIPS 399337.11A of April 1973.

Comparisons - breakdowns are presented for the following:

The comparisons - breakdowns do not include any of the LAMPS requirements.

1. SUMMARY OF ORGANIZATIONAL MANNING REQUIREMENTS

	BREAKDOWN				SKILL APPORTIONMENT				
	Total	Officers	CPO	Other Enlisted	PO	Strikers	Non-Rated	Officers	Total
DEG-1	259	17	16	226	57.02%	16.94%	26.04%	N.A.	100%
PF	176	10 + 4 = 14	13 + 1 = 14	135 + 13 LAMPS = 148	68.2%	N.A.	23.8%	8%	100%

2. PAY GRADE SUMMARY

	0-5	0-4	0-3	0-2	0-1	E-9	E-8	E-7	E-6	E-5	E-4	E-3	E-2	TOTAL
DEG-1	1	1	5	7	3	0	3	13	28	41	53	93*	11	259
PF	0	1	7	4	2	2	3	9	31	40	35	39	3	176

* Includes "STRIKERS"
E-2 and E-3

3. OFFICER SUMMARY (LAMPS NOT INCLUDED)

DEG-1 Commissioned Officers	PF Commissioned Officers	PF Enlisted Division Officers
Commanding Officer	Commanding Officer	
Executive Officer	Executive Officer/Navigator	
Navigator	———	
Operations Officer	Operations Department Officer	
CIC Officer/EMO	———	CIC Division Officer (OSC)
Communications Officer	Communications Officer	
Weapons Officer	Combat Systems Department Officer	
ASW Officer	ASW Division Officer	
Sonar Officer	———	
Missile Officer	———	Ordnance Division Officer (FTCS)
First Lieutenant	———	Deck Division Officer (BMCM)
Engineer Officer	Electronic Readiness Division Officer	
Damage Control Assistant	Damage Control Assistant	
Main Propulsion Assistant	———	Main Propulsion Division Officer (GSCS)
Supply Officer	Supply Department Officer/Disbursing	
Disbursing Officer	———	Supply Division Officer (CSC)
Medical Officer	———	Food Service Division Officer (CSC)

4. WATCH STATIONS (NO LAMPS) (OFFICERS & ENLISTED

	CONDITION I		CONDITION III	
	DEG-1	PF	DEG-1	PF
Pilot House/Bridge	20	14	9	6
Aft Steering	2	3	1	-
CIC + Sonar	38	26	14	11
Communications (Radio Control)	11	12	3	3
Weapons Control	20	(Same as CIC)	4	(Same as CIC)
Weapons	17 + 5	9	4	-
Electronic Cas. Ctl	11	13	-	-
Eng. Ctl./Eng.	22	26	9	3
Damage Ctl.	53	44	2	1
Battle Messing	3	4	-	-
Supply	1	2	-	-

5. COMMISSIONED OFFICER WATCHES (NOT INCLUDING LAMPS)

		CONDITION I		CONDITION III	
	SHIP	DEG-1	PF	DEG-1	PF
Commanding Officer	B	Bridge	Bridge - CIC	N.A.	N.A.
Executive Officer	B	Bridge/CIC	OOD	N.A.	N.A.
Navigator	D	OOD	N.A.	OOD	N.A.
Operations Officer	B	CIC Evaluator	CIC Evaluator	CIC Watch	CIC Watch
CIC Officer/EMO	D	CIC	N.A.	CIC Watch	N.A.
Communications Officer	B	TACOM	Radio Central	CIC Watch	OOD
Weapons/Combat Sys Officer	B	CIC Wpns Control	CIC WCC Operator	OOD	CIC Watch
ASW Officer	B	UB Plot	ASW Attack Officer	Dir. Officer	OOD
Sonar Officer	D	WLO/Wpn. Cont.	N.A.	Dir. Officer	N. A.
Missile Officer	D	?	N.A.	JOOW	N.A.
Electronic Readiness Off.	D	N.A.	CIC/Radar Equip. Room		CIC Watch
First Lieutenant	D	Director Off.	N.A.	Director Off.	N.A.
Engineer Officer	B	Main Eng. Ctl.	Main Eng. Ctl.	OOD	OOD
Main Propulsion Ass't	D	Fire Room		JOOW	N.A.
Damage Control Ass't	B	Damage Control Central	DCC Central	JOOW	N.A.
Supply Officer	B	Crypto	Cent. Off. Complex	N.A.	N.A.
Disbursing Officer	D	Crypto	N.A.	N.A.	N.A.
Medical Officer	D	Bat. Dress Sta.	N.A.	N.A.	N.A.

D - DEG-1 Officer Only
P - PF Officer Only
B - Both PF & DEG-1 Officer

6. FUNCTIONAL COMPARISON (ENLISTED - NO LAMPS)

Functional Areas	DEG-1	PF
Administrative/Supply/Disbursing/Support YN/PN/SK/DK/PC/SH/HM/E8-E9/CMAA	26	17
CIC/Ship Control OS/EW/FT/ET/DS/ST/QM	62	44
Communications RM/SM	18	12
Deck BM	37	17
Ordnance TM/GM	11	8
Main Propulsion MM/BT/GS	42	14
DC/Auxiliaries EM/EN/NT/MR/IC	20	21
Food Service CS/SD/Messcooks	28	15
TOTAL	244	148

7. ENLISTED ORGANIZATIONAL REQUIREMENTS SUMMARY (NO LAMPS)

Rate/Rating	DEG-1	PF
BMCM	---	1
BMC	2	--
BMI	1	1
BM2	1	1
BM3	3	1
BMSN	30	13
BMSA	--	--
BM Total	37	17
BTCS	1	--
BTI	2	--
BT2	3	--
BT3	5	--
BTFN	8	--
BT Total	19	0
CSC	--	1
CSI	2	--
CS2	1	3
CS3	2	1
CSSN	16	--
CS Total	21	5**
DK1	1	--
DK2	--	1
DK Total	1	1
DSCM	--	1
DSI	--	1
DS2	--	1
DS Total	0	3
EMC	--	1
EMI	1	1
EM2	1	1
EM3	2	1
EMFN	1	2
EM Total	5	6
ENC		
ENI	1	1
EN2	--	1
EN3	1	--
ENFN	--	2
EN Total	2	4

** See SN/SA for Messcooks

7. ENLISTED ORGANIZATIONAL REQUIREMENTS SUMMARY (NO LAMPS) cont'd.

Rate/Rating	DEG-1	PF
ETC	1	1
ETI		
ET2	2	2
ET3	3	2
ETSN	1	--
ET Total	7	5
EWI	--	1
EW2	--	1
EW3	--	1
EW Total	--	3
FTGI	--	1
FTG2	1	1
FTG3	1	1
FTGSN	3	--
FTGSA	2	--
FTG Total	7	3
FTCM	1	--
FTCS	--	1
FTMI	2	2
FTM2	2	2
FTM3	2	2
FTMSN	1	
FTM Total	7	6
FT Total	15	10
GMMC	1	--
GMM1	1	1
GMM2	1	1
GMM3	1	--
GMM Total	4	2
GMG1	2	--
GMG2	2	1
GMG3	2	2
GMGSN	--	1
GMG Total	6	4
GM Total	10	6
GSCS	--	1
GSC	--	1
GS1	--	2
GS2	--	2
GS3	--	4
GSFN	--	4
GS Total		14

7. ENLISTED ORGANIZATIONAL REQUIREMENTS SUMMARY (NO LAMPS) cont'd.

Rate/Rating	DEG-1	PF
HMC	1	--
HM1		1
HN	1	--
HM Total	2	1
HT1	1	1
HT2	2	1
HT3	1	2
HTFN	3	1
HT Total	7	5
IC1	1	1
IC2	1	1
IC3	2	1
ICFN	1	--
IC Total	5	3
MMC	2	--
MM1	3	--
MM2	4	--
MM3	3	--
MMFN	8	--
MMFA	3	--
MM Total	23	0
MR2	1	1
MRFN	--	2
MR Total	1	3
OSC	1	1
OS1	2	2
OS2	5	3
OS3	4	4
OSSN	8	2
OSSA	--	--
OS Total	20	12
PC3	1	--
PC Total	1	0
PN1	1	--
PN2	--	1
PNSN	1	--
PN Total	2	1

7. ENLISTED ORGANIZATIONAL REQUIREMENTS SUMMARY (NO LAMPS) cont'd.

Rate/Rating	DEG-1	PF
QMC	1	--
QM1	--	1
QM2	1	1
QM3	2	2
QMSN	1	--
QM Total	5	4
RMC	1	1
RM1	1	1
RM2	3	1
RM3	3	3
RMSN	4	2
RM Total	12	9
SA	18*	3 (Messcooks)
SN	6*	4 "
Seamen Total	24*	7
SD1	1	1
SD2	1	--
SD3	1	--
SDSN	4	2
SD Total	7	3
SH1	1	1
SH2	--	1
SH3	2	1
SHSN	3	3
SH Total	6	6
SKC	1	1
SKI	1	1
SK2	1	2
SK3	2	1
SKSN	1	--
SK Total	6	5
SM1	1	1
SM2	2	1
SM3	3	1
SM Total	6	3
STCS	1	--
STC		1
ST1	3	2
STG2	4	2
STG3	4	2
STGSN	3	--
ST Total	15	7

* Deck Service

7. ENLISTED ORGANIZATIONAL REQUIREMENTS SUMMARY (NO LAMPS) cont'd.

Rate/Rating	DEG-1	PF
TM2	1	1
TMSN	--	1
TM Total	1	2
YNCS	--	1
YNC	1	--
YN1	--	1
YN3	3	1
YNSN	1	--
YN Total	5	3
E8/EQ 9513	1	--
	1	0

8. PM/CM WEEKLY MAN-HOUR REQUIREMENTS

	PM		CM		CM & PM	
	DDG-1 PM	PF PM	DDG-1 CM	PF CM	DDG-1 TOTAL	PF TOTAL
RATING						
BM	60.82	18.18	27.12	9.09	87.94	27.27
BT	152.66	-	73.89	-	226.55	-
CS	9.00	1.50	4.50	.75	13.50	2.25
DK	-	-	-	-	-	-
DS	-	21.65	-	21.65	-	43.30
EM	54.41	85.12	27.21	39.07	81.53	124.19
EN	23.29	52.50	11.65	23.96	34.94	76.46
ETN	25.99	26.14	59.49	40.97	85.48	67.11
ETR	11.04	15.14	31.87	22.75	42.91	37.89
EW	-	2.29	-	2.29	-	4.58
FTG	30.21	4.00	15.10	10.11	45.31	14.11
FTM	35.25	23.75	17.65	24.75	52.90	48.50
GMM	53.83	26.66	12.92	13.34	66.75	40.00
GMG	32.82	30.32	30.40	15.16	63.22	45.48
GS	-	40.70	-	17.57	-	58.27
HT	42.24	16.01	18.79	8.35	61.03	24.36
IC	52.09	8.56	28.06	19.38	80.15	27.94
MM	96.09	-	48.03	-	144.12	-
MR	.79	19.37	.40	7.51	1.19	26.88
OS	18.21	21.11	11.38	3.00	29.59	24.11
PC	-	-	-	-	-	-
PN	-	-	-	-	-	-
QM	.36	3.20	-	1.78	.36	4.98
RM	41.96	36.06	2.74	12.20	44.70	48.26
SD	-	-	-	-	-	-
SH	-	-	-	-	-	-
SK	-	-	-	-	-	-
SM	.54	.14	-	.14	.54	.28
ST	21.25	19.82	9.52	19.10	30.77	38.92
TM	9.28	16.53	4.64	8.27	13.92	24.80
YN	-	-	-	-	-	-
TOTAL	768.21	488.75	435.36	321.19	1177.40	809.94

9. -OTHER- WEEKLY MAN-HOUR REQUIREMENTS

FM-UT-AS

Rating	FM DEG-1	FM PF	UT DEG-1	UT PF	AS DEG-1	AS PF	TOTAL FM+UT+AS DEG-1	TOTAL FM+UT+AS PF
BM	307.13	262.95	204.77	137.50	14.05	46.18	525.95	446.63
BT	65.57	-	86.04	-	9.00	-	160.61	-
*CS	131.73	114.84	182.06	41.25	122.05	351.29	435.84	507.38
DK	3.75	-	-	1.75	45.75	18.29	49.50	20.04
DS	-	3.48	-	11.00	-	7.01	-	21.49
EM	9.29	20.80	8.38	27.25	11.06	5.00	28.73	53.05
EN	3.52	20.80	5.47	35.50	4.60	2.10	13.59	58.40
ET	11.53	13.96	45.63	31.00	30.74	9.92	87.90	54.88
EW	-	11.25	-	1.25	-	-	-	12.50
FT	96.49	28.25	117.86	18.00	35.10	14.47	249.45	60.72
GM	33.16	27.64	143.88	23.00	45.06	3.15	222.10	53.79
GS	-	64.58	-	59.00	-	42.29	-	165.87
HT	16.88	31.22	83.68	52.00	7.47	3.79	108.03	87.01
HM	1.35	-	65.83	8.50	28.52	25.87	95.70	34.37
IC	5.40	3.48	20.20	20.50	8.68	.40	34.28	24.38
MM	99.77	-	458.36	-	55.99	-	614.12	-
MR	2.97	31.20	44.87	5.25	1.35	.90	49.19	37.35
OS	36.09	32.33	64.59	21.25	12.96	46.40	113.64	99.98
PC	2.16	-	18.58	-	29.26	-	50.00	-
PN	-	5.78	9.46	5.50	90.33	36.12	99.79	47.40
QM	16.27	17.92	41.74	22.25	74.84	27.69	132.85	67.86
RM	24.72	34.09	52.00	15.00	117.24	16.25	193.96	65.34
SD	41.58	32.80	23.80	4.00	281.12	59.79	346.50	96.59
SH	49.14	54.88	23.54	33.25	223.26	168.49	295.94	256.62
SK	35.54	13.72	23.81	5.25	197.15	137.80	256.50	156.77
SM	-	5.01	30.84	20.75	31.56	6.41	62.40	32.17
ST	102.52	22.53	48.50	8.50	46.39	8.91	197.41	39.94
TM	5.35	5.63	25.91	7.50	.54	-	31.80	13.13
YN	20.15	10.98	76.76	5.50	110.90	78.01	207.81	94 49
CMAA					50.00		50.00	-
E8/E9					50.00		50.00	-
TOTAL	1122.06	866.43	1906.56	629.50	1734.97	1116.53	5013.04	2608.15

*Includes Messcooks

(NO LAMPS)

10. TOTAL MAN-HOUR WORK REQUIREMENTS

(NOT INCLUDING WATCH REQUIREMENTS OR LAMPS)

Ratings	PM/CM		Other		# Billets	PM/CM + Other Total	# Billets	
	DEG-1	PF	DEG-1	PF	DEG-1	DEG-1	PF	PF
BM	87.94	27.27	529.95	446.63	37	617.89	17	473.90
BT	226.55	-	160.61	-	19	387.16	0	-
*CS	13.50	2.25	435.84	507.38	21	449.34	12	509.63
DK	-	-	49.50	20.04	1	49.50	1	20.04
DS	-	43.30	-	21.49	0	-	3	64.79
EM	81.53	124.19	28.73	53.05	5	110.26	6	177.24
EN	34.94	76.46	13.59	58.40	2	48.53	4	134.86
ET	128.39	105.00	87.90	54.88	7	216.29	5	159.88
EW	-	4.58	-	12.50	0	-	3	17.08
FT	98.21	62.61	249.45	60.72	15	347.66	10	123.33
GM	129.97	85.48	222.10	53.79	10	352.07	6	139.27
GS	-	58.27	-	165.87	0	-	14	224.14
HT	61.03	24.36	108.03	87.01	7	169.06	5	111.37
HM	-	-	95.70	34.37	2	95.70	1	34.37
IC	80.15	27.94	34.28	24.38	5	114.43	3	52.38
MM	144.12	-	614.12	-	23	758.24	0	-
MR	1.19	26.88	49.19	37.35	1	50.38	3	64.23
OS	29.59	24.11	113.64	99.98	20	143.23	12	124.09
PC	-	-	50.00	-	1	50.00	0	-
PN	-	-	99.79	47.40	2	99.79	1	47.40
QM	.36	4.98	132.85	67.86	5	133.21	4	72.84
RM	44.70	48.26	193.96	65.34	12	238.66	9	113.60
SD	-	-	346.50	96.59	7	346.50	3	96.59
SH	-	-	295.94	256.62	6	295.94	6	256.62
SK	-	-	256.50	156.77	6	256.50	5	156.77
SM	.54	.28	62.40	32.17	6	62.94	3	32.45
ST	30.77	38.92	197.41	39.94	15	228.18	7	78.86
TM	13.92	24.80	31.80	13.13	1	45.72	2	37.93
YN	-	-	207.81	94.49	5	207.81	3	94.49
CMAA	-	-	50.00	-	1	50.00	0	-
E8/E9	-	-	50.00	-	1	50.00	0	-
TOTAL	1177.40	809.94	5063.04	2608.15	242	5974.99	148	3418.15

*Includes Messcooks

SEPTEMBER 74

PREPARED '1 APR 75 SHIPMENTS MOVING OVER SELECTED CHANNELS PAGE NO. 16

MAN STA	CHANNEL APOE APOD	PRI	SHPMT	PHT	PIECES	WEIGHT LBS	CUBE
NAP	NAP NGU	1	17	75	18	1761	111
NAP	NAP NGU	1	1	79	1	26[illegible]	3[illegible]
NAP	NAP NGU	1	1	99	1	1200	120
NAP	NAP NGU	1	1	114	1	1463	151
NAP	NAP NGU	1	2	115	2	1943	274
NAP	NAP NGU	1	4	12[illegible]	5	1557	78
NAP	NAP NGU	1	1	123	1	1456	156
NAP	NAP NGU	1	1	138	1	17253	2196
NAP	NAP NGU	1	1	151	1	357	58
NAP	NAP NGU	1	1	166	4	1486	246
NAF	NAP NGU	1	1	172	1	649	5[illegible]
NAP	NAP NGU	1	1	197	1	135	8
NAP	NAP NGU	1	2	365	2	73	2
NAP	NAP NGU	1	1	366	2	13	8
TOTAL	FOR PRI	1	92	71	106	57176	5658
NAP	NAP NGU	2	3	20	3	661	61
NAP	NAP NGU	2	2	21	3	1635	222
NAP	NAP NGU	2	1	23	1	116	4
NAP	NAP NGU	2	2	24	2	108	8
NAP	NAP NGU	2	6	25	16	3[illegible]97	349
NAP	NAP NGU	2	6	28	13	2969	211
NAP	NAP NGU	2	13	29	14	12811	916
NAP	NAP NGU	2	32	4[illegible]	35	14761	158[illegible]
NAP	NAP NGU	2	15	43	31	1464	131
NAP	NAP NGU	2	35	45	58	9147	42[illegible]
NAP	NAP NGU	2	3	46	14	2518	273
NAP	NAP NGU	2	34	47	35	3472	336
NAP	NAP NGU	2	14	5[illegible]	31	762[illegible]	821
NAP	NAP NGU	2	2	52	2	165	12
NAF	NAF NGU	2	1	53	1	5	1
NAP	NAP NGU	2	10	55	18	2915	221
NAP	NAP NGU	2	1	56	1	6[illegible]	3

MAN STA - MANIFESTING STATION

NAP - NAPLES

NGU - NORFOLK

APOE - AERIAL PORT OF EMBARKATION

APOD - AERIAL PORT OF DEBARKATION

PRI - PRIORITY

SHPMT - NUMBER OF SHIPMENTS

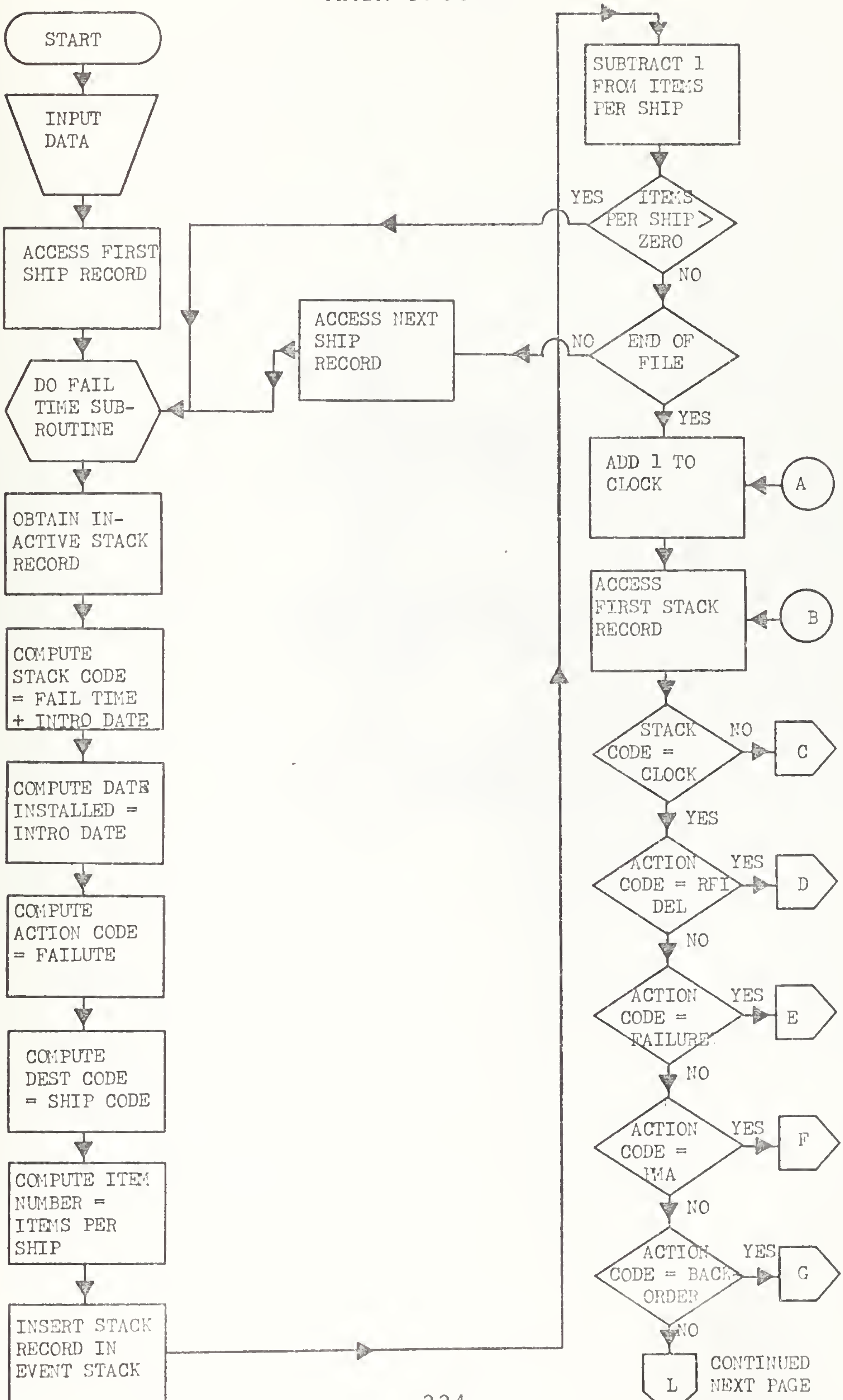
PHT - PORT HOLD TIME (HOURS)

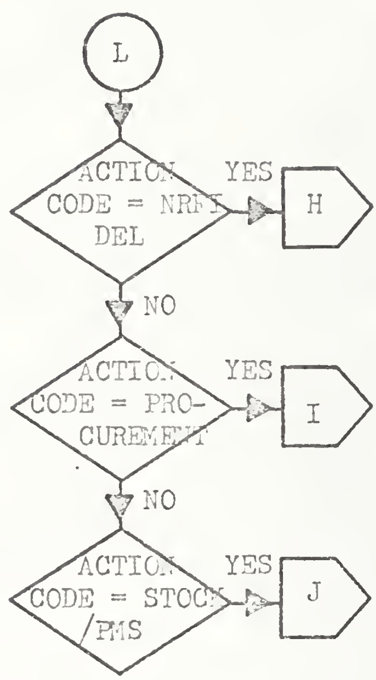
AVERAGE PORT HOLD TIME FOR TOTAL SHIPMENTS

APPENDIX C

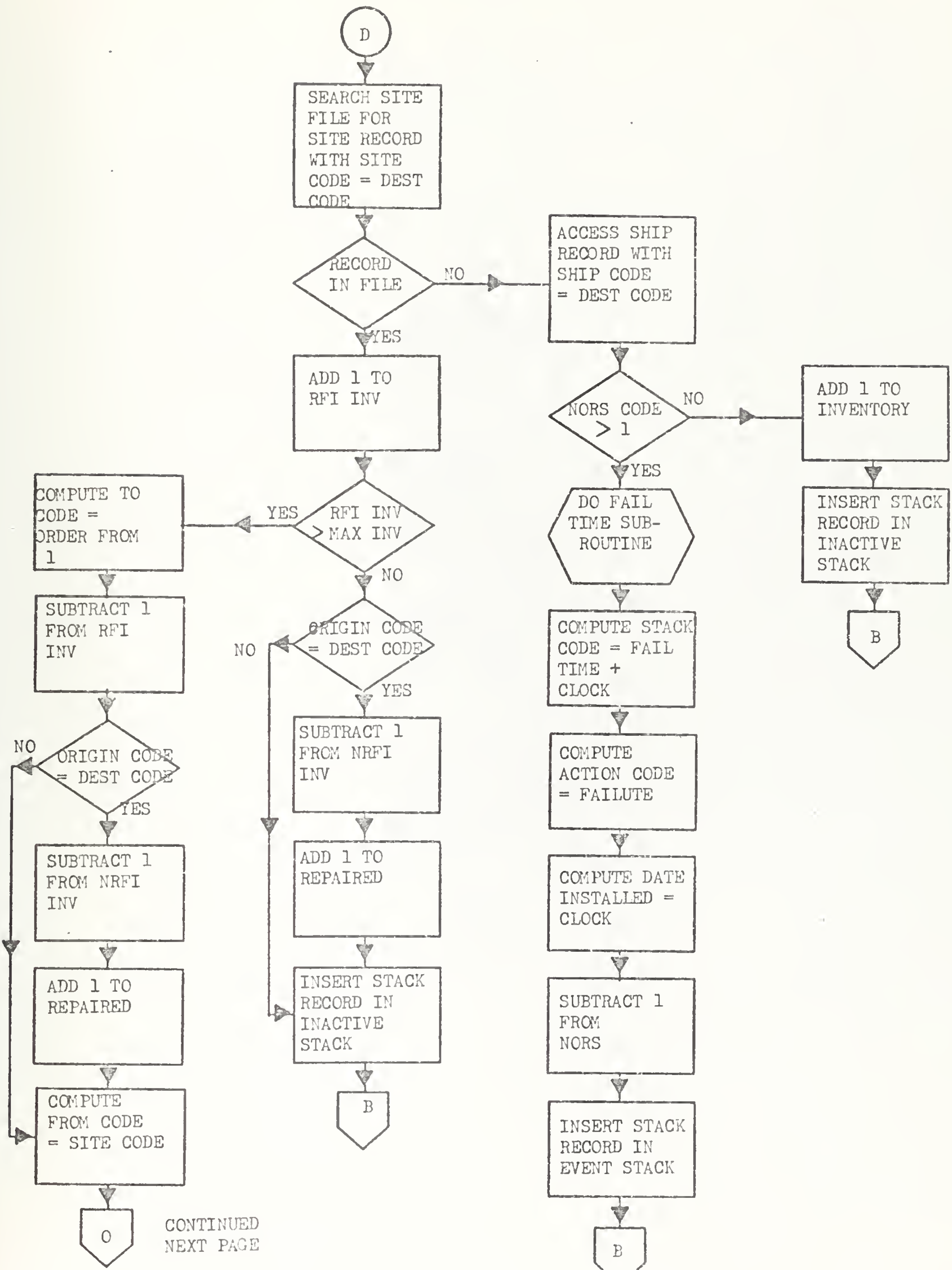
FLOWCHART OF THE REPAIRABLES SIMULATION

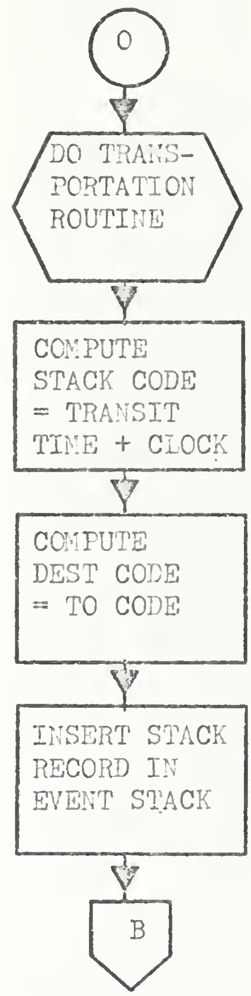
MAIN PROGRAM



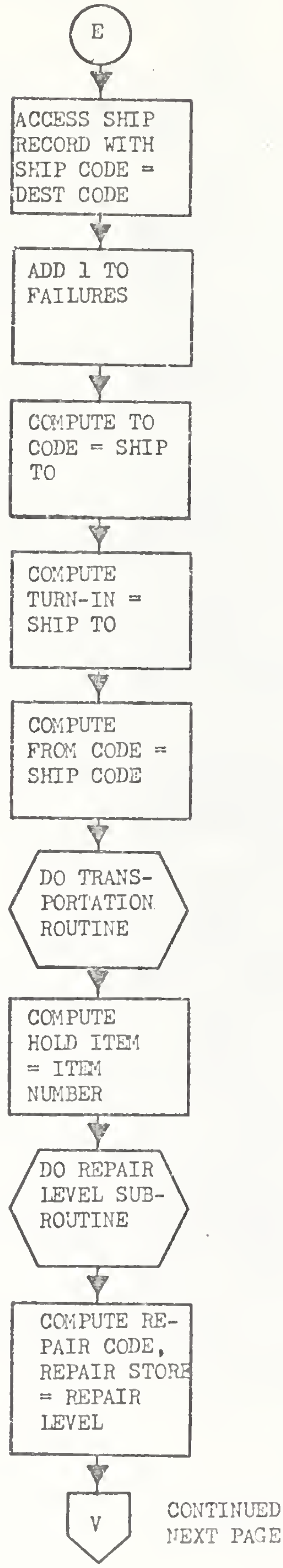

L
ACTION CODE = NRFI DEL
YES
H
NO
ACTION CODE = PRO- CUREMENT
YES
I
NO
ACTION CODE = STOCK /PMS
YES
J

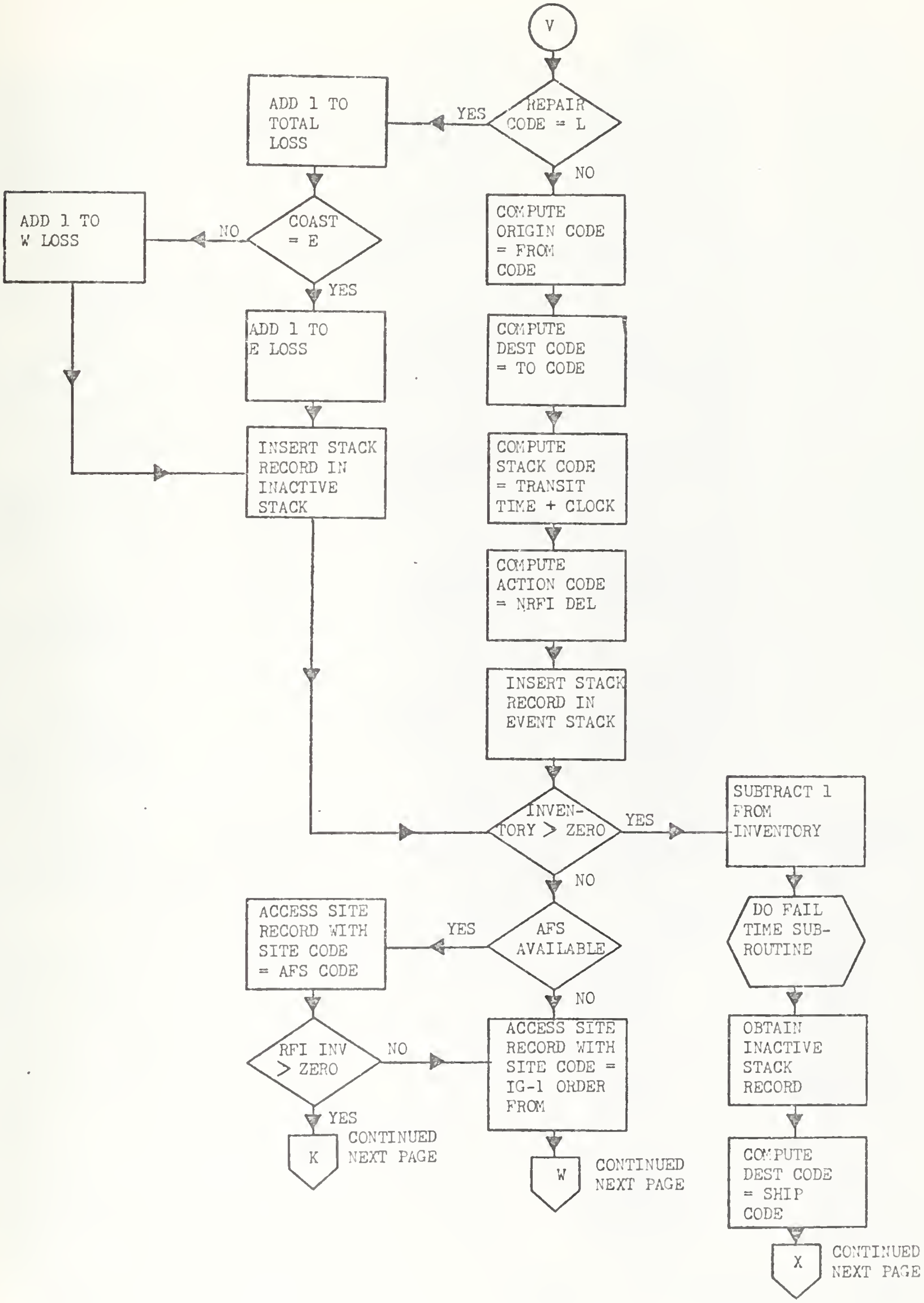
RFI DELIVERY ROUTINE

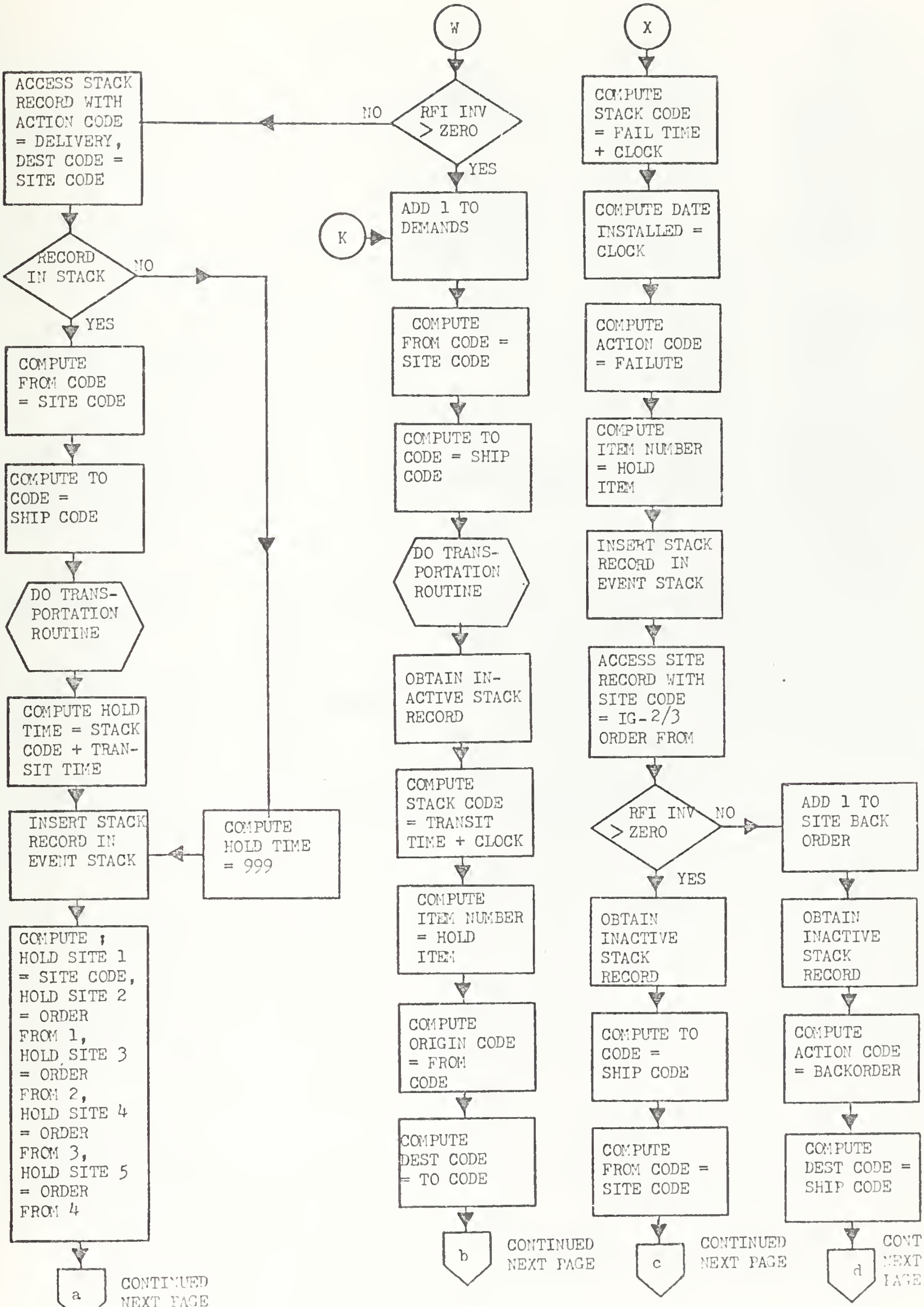


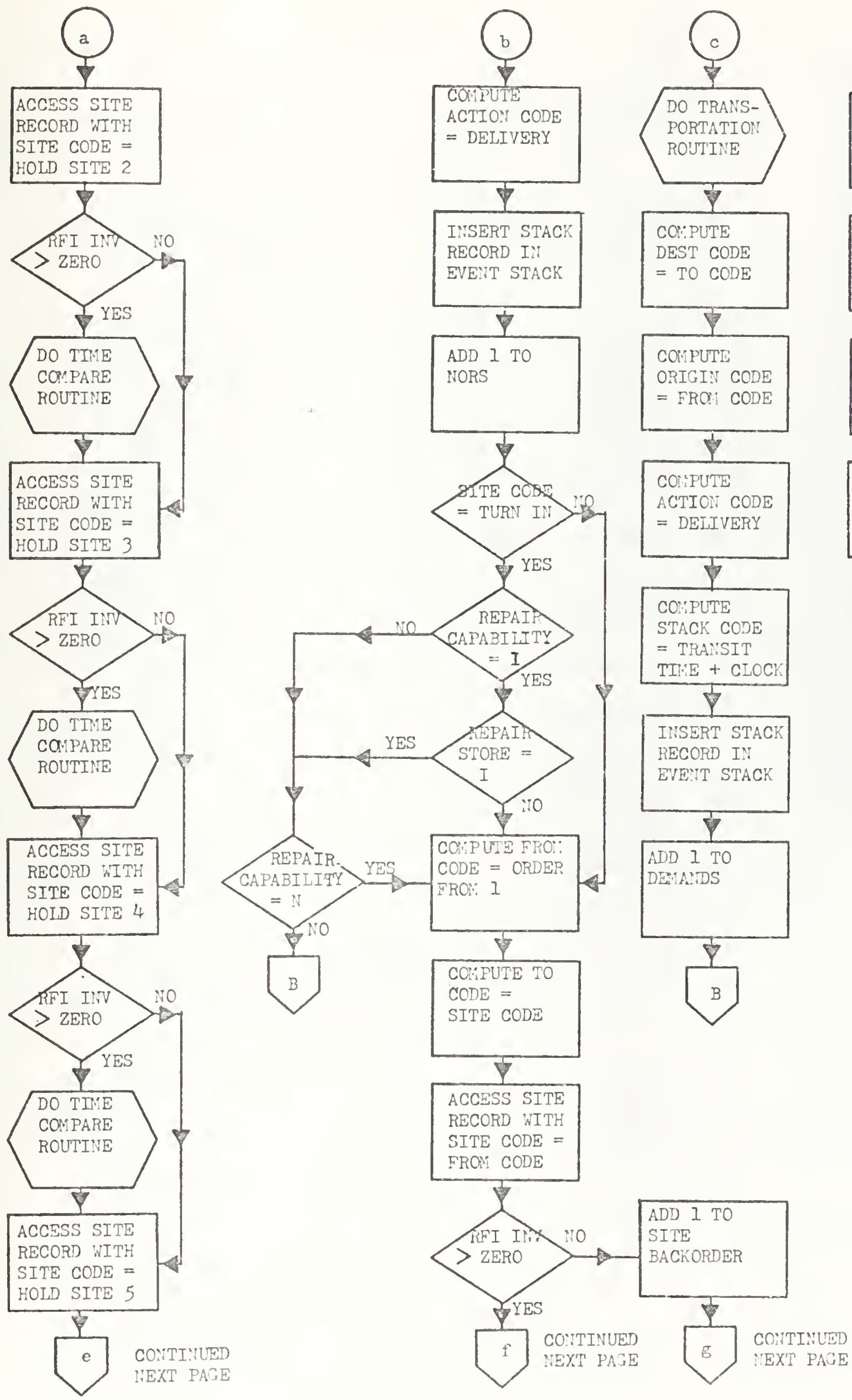

O
DO TRANS-PORTATION ROUTINE
COMPUTE STACK CODE = TRANSIT TIME + CLOCK
COMPUTE DEST CODE = TO CODE
INSERT STACK RECORD IN EVENT STACK
B

FAILURE ROUTINE

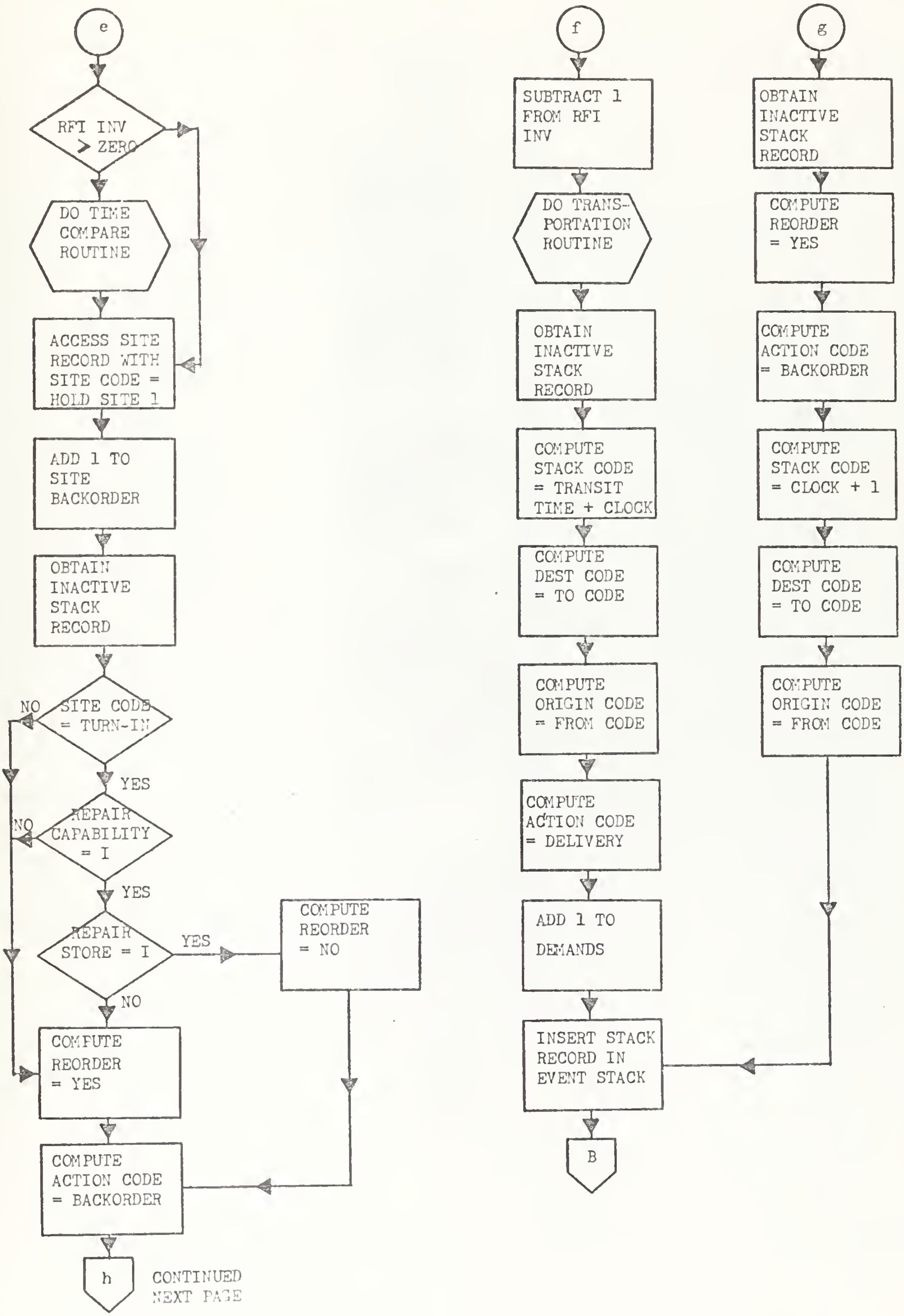


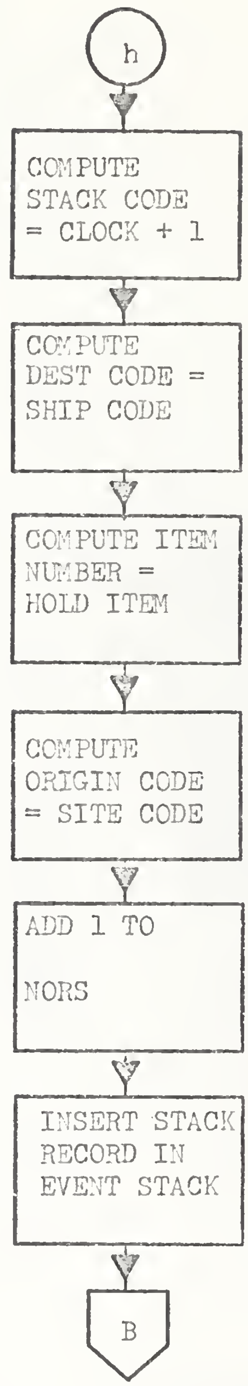

V
REPAIR CODE = L
YES
NO
ADD 1 TO TOTAL LOSS
COAST = E
NO
YES
ADD 1 TO W LOSS
ADD 1 TO E LOSS
INSERT STACK RECORD IN INACTIVE STACK
COMPUTE ORIGIN CODE = FROM CODE
COMPUTE DEST CODE = TO CODE
COMPUTE STACK CODE = TRANSIT TIME + CLOCK
COMPUTE ACTION CODE = NRFI DEL
INSERT STACK RECORD IN EVENT STACK
INVENTORY > ZERO
YES
NO
SUBTRACT 1 FROM INVENTORY
DO FAIL TIME SUB-ROUTINE
OBTAIN INACTIVE STACK RECORD
COMPUTE DEST CODE = SHIP CODE
X
CONTINUED NEXT PAGE
AFS AVAILABLE
YES
NO
ACCESS SITE RECORD WITH SITE CODE = AFS CODE
RFI INV > ZERO
NO
YES
K
CONTINUED NEXT PAGE
ACCESS SITE RECORD WITH SITE CODE = IG-1 ORDER FROM
W
CONTINUED NEXT PAGE


W
X
RFI INV > ZERO
NO
YES
ACCESS STACK RECORD WITH ACTION CODE = DELIVERY, DEST CODE = SITE CODE
RECORD IN STACK
NO
YES
COMPUTE FROM CODE = SITE CODE
COMPUTE TO CODE = SHIP CODE
DO TRANS-PORTATION ROUTINE
COMPUTE HOLD TIME = STACK CODE + TRAN-SIT TIME
INSERT STACK RECORD IN EVENT STACK
COMPUTE HOLD TIME = 999
COMPUTE ; HOLD SITE 1 = SITE CODE, HOLD SITE 2 = ORDER FROM 1, HOLD SITE 3 = ORDER FROM 2, HOLD SITE 4 = ORDER FROM 3, HOLD SITE 5 = ORDER FROM 4
a
CONTINUED NEXT PAGE
K
ADD 1 TO DEMANDS
COMPUTE FROM CODE = SITE CODE
COMPUTE TO CODE = SHIP CODE
DO TRANS-PORTATION ROUTINE
OBTAIN IN-ACTIVE STACK RECORD
COMPUTE STACK CODE = TRANSIT TIME + CLOCK
COMPUTE ITEM NUMBER = HOLD ITEM
COMPUTE ORIGIN CODE = FROM CODE
COMPUTE DEST CODE = TO CODE
b
CONTINUED NEXT PAGE
COMPUTE STACK CODE = FAIL TIME + CLOCK
COMPUTE DATE INSTALLED = CLOCK
COMPUTE ACTION CODE = FAILUTE
COMPUTE ITEM NUMBER = HOLD ITEM
INSERT STACK RECORD IN EVENT STACK
ACCESS SITE RECORD WITH SITE CODE = IG-2/3 ORDER FROM
RFI INV > ZERO
NO
YES
OBTAIN INACTIVE STACK RECORD
COMPUTE TO CODE = SHIP CODE
COMPUTE FROM CODE = SITE CODE
c
CONTINUED NEXT PAGE
ADD 1 TO SITE BACK ORDER
OBTAIN INACTIVE STACK RECORD
COMPUTE ACTION CODE = BACKORDER
COMPUTE DEST CODE = SHIP CODE
d
CONT. NEXT PAGE

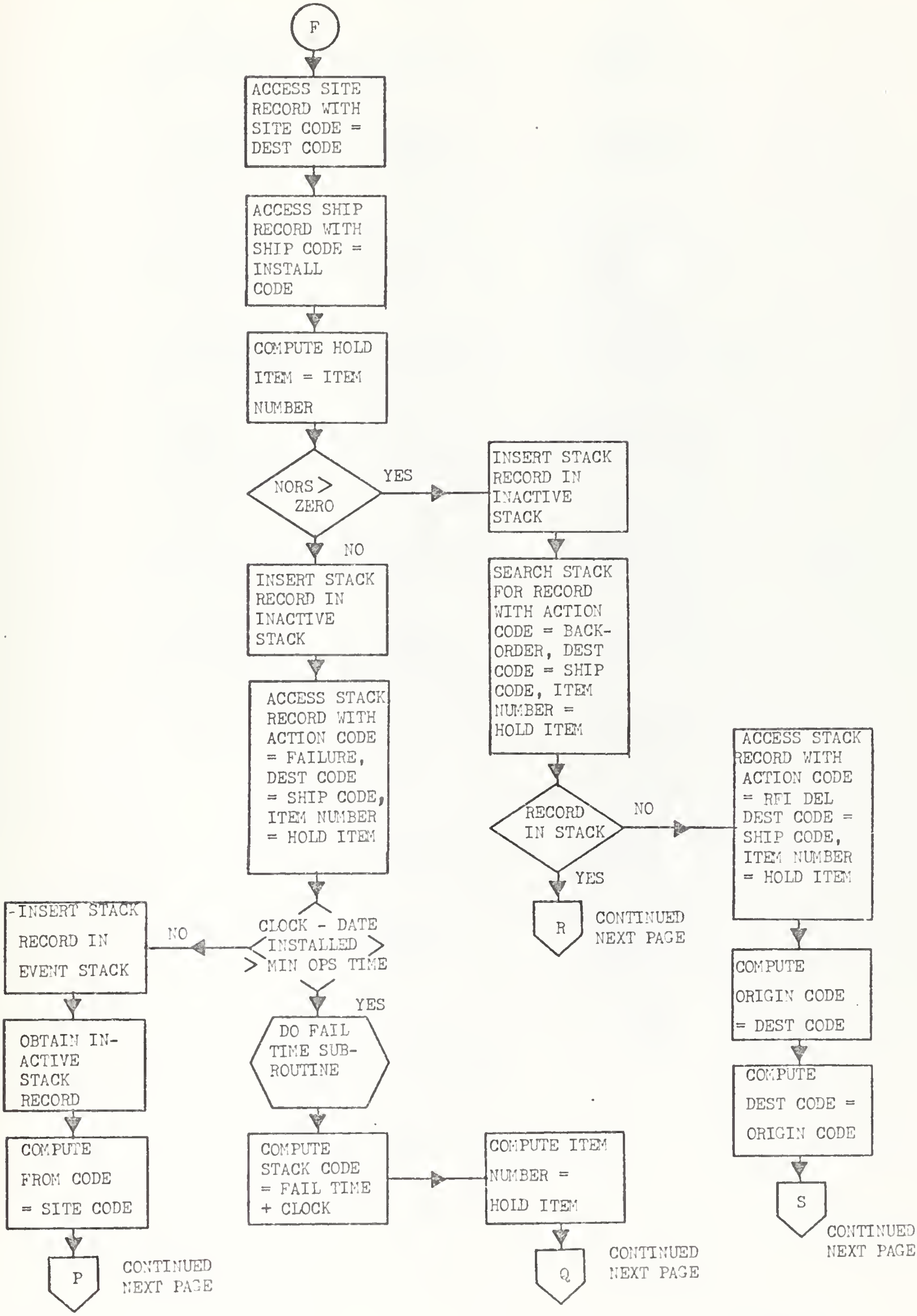


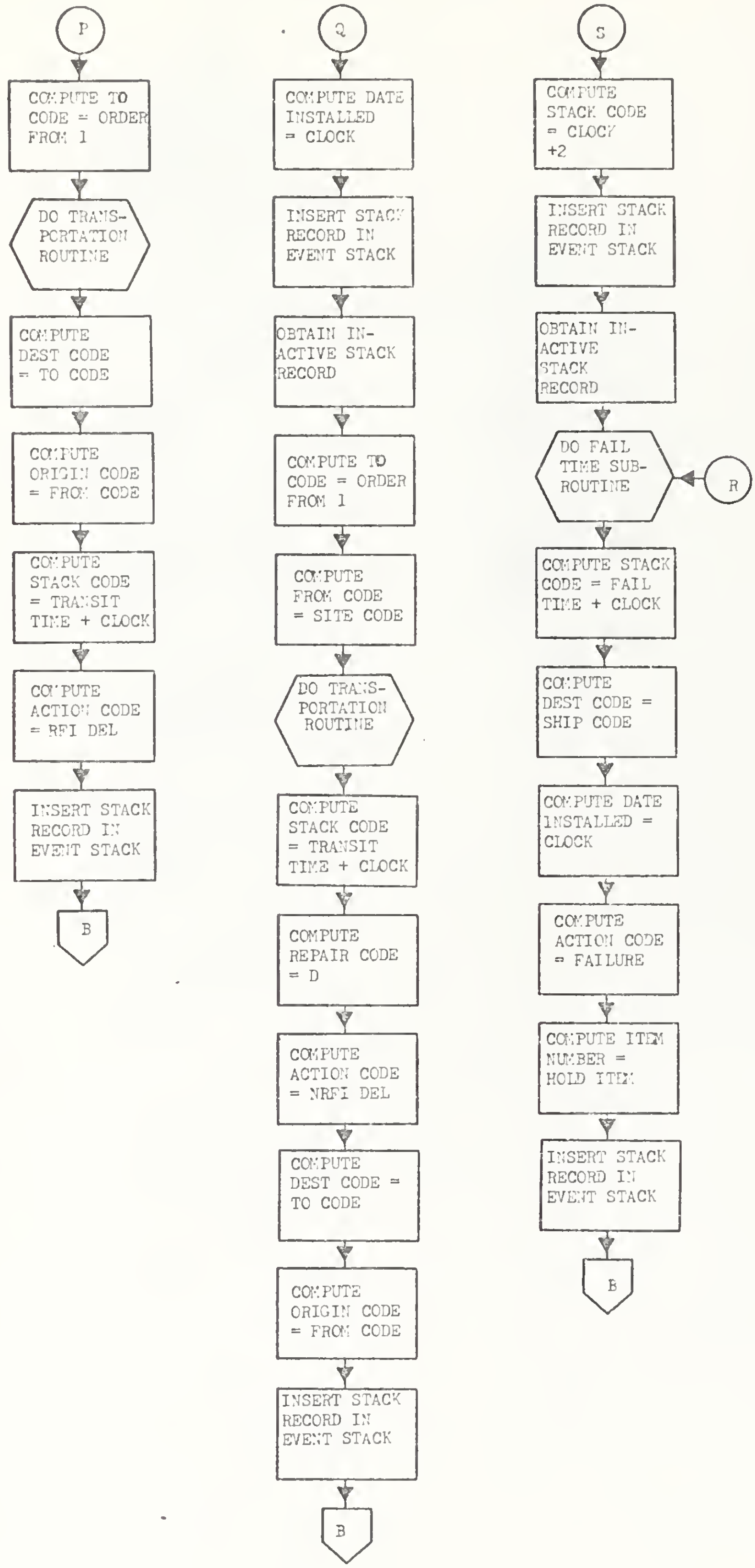
a
ACCESS SITE RECORD WITH SITE CODE = HOLD SITE 2
RFI INV > ZERO
NO
YES
DO TIME COMPARE ROUTINE
ACCESS SITE RECORD WITH SITE CODE = HOLD SITE 3
RFI INV > ZERO
NO
YES
DO TIME COMPARE ROUTINE
ACCESS SITE RECORD WITH SITE CODE = HOLD SITE 4
RFI INV > ZERO
NO
YES
DO TIME COMPARE ROUTINE
ACCESS SITE RECORD WITH SITE CODE = HOLD SITE 5
e
CONTINUED NEXT PAGE
b
COMPUTE ACTION CODE = DELIVERY
INSERT STACK RECORD IN EVENT STACK
ADD 1 TO NORS
SITE CODE = TURN IN
NO
YES
REPAIR CAPABILITY = I
NO
YES
REPAIR STORE = I
YES
NO
REPAIR CAPABILITY = N
YES
NO
B
COMPUTE FROM CODE = ORDER FROM 1
COMPUTE TO CODE = SITE CODE
ACCESS SITE RECORD WITH SITE CODE = FROM CODE
RFI INV > ZERO
NO
YES
ADD 1 TO SITE BACKORDER
f
CONTINUED NEXT PAGE
g
CONTINUED NEXT PAGE
c
DO TRANS-PORTATION ROUTINE
COMPUTE DEST CODE = TO CODE
COMPUTE ORIGIN CODE = FROM CODE
COMPUTE ACTION CODE = DELIVERY
COMPUTE STACK CODE = TRANSIT TIME + CLOCK
INSERT STACK RECORD IN EVENT STACK
ADD 1 TO DEMANDS
B
d
COMPUTE ORIGIN CODE = SITE CODE
COMPUTE STACK CODE = CLOCK + 1
COMPUTE REORDER = NO
INSERT STACK RECORD IN EVENT STACK
B


e
RFI INV > ZERO
DO TIME COMPARE ROUTINE
ACCESS SITE RECORD WITH SITE CODE = HOLD SITE 1
ADD 1 TO SITE BACKORDER
OBTAIN INACTIVE STACK RECORD
NO
SITE CODE = TURN-IN
YES
NO
REPAIR CAPABILITY = I
YES
REPAIR STORE = I
YES
COMPUTE REORDER = NO
NO
COMPUTE REORDER = YES
COMPUTE ACTION CODE = BACKORDER
h
CONTINUED NEXT PAGE
f
SUBTRACT 1 FROM RFI INV
DO TRANS-PORTATION ROUTINE
OBTAIN INACTIVE STACK RECORD
COMPUTE STACK CODE = TRANSIT TIME + CLOCK
COMPUTE DEST CODE = TO CODE
COMPUTE ORIGIN CODE = FROM CODE
COMPUTE ACTION CODE = DELIVERY
ADD 1 TO DEMANDS
INSERT STACK RECORD IN EVENT STACK
B
g
OBTAIN INACTIVE STACK RECORD
COMPUTE REORDER = YES
COMPUTE ACTION CODE = BACKORDER
COMPUTE STACK CODE = CLOCK + 1
COMPUTE DEST CODE = TO CODE
COMPUTE ORIGIN CODE = FROM CODE


h
COMPUTE STACK CODE = CLOCK + 1
COMPUTE DEST CODE = SHIP CODE
COMPUTE ITEM NUMBER = HOLD ITEM
COMPUTE ORIGIN CODE = SITE CODE
ADD 1 TO NORS
INSERT STACK RECORD IN EVENT STACK
B

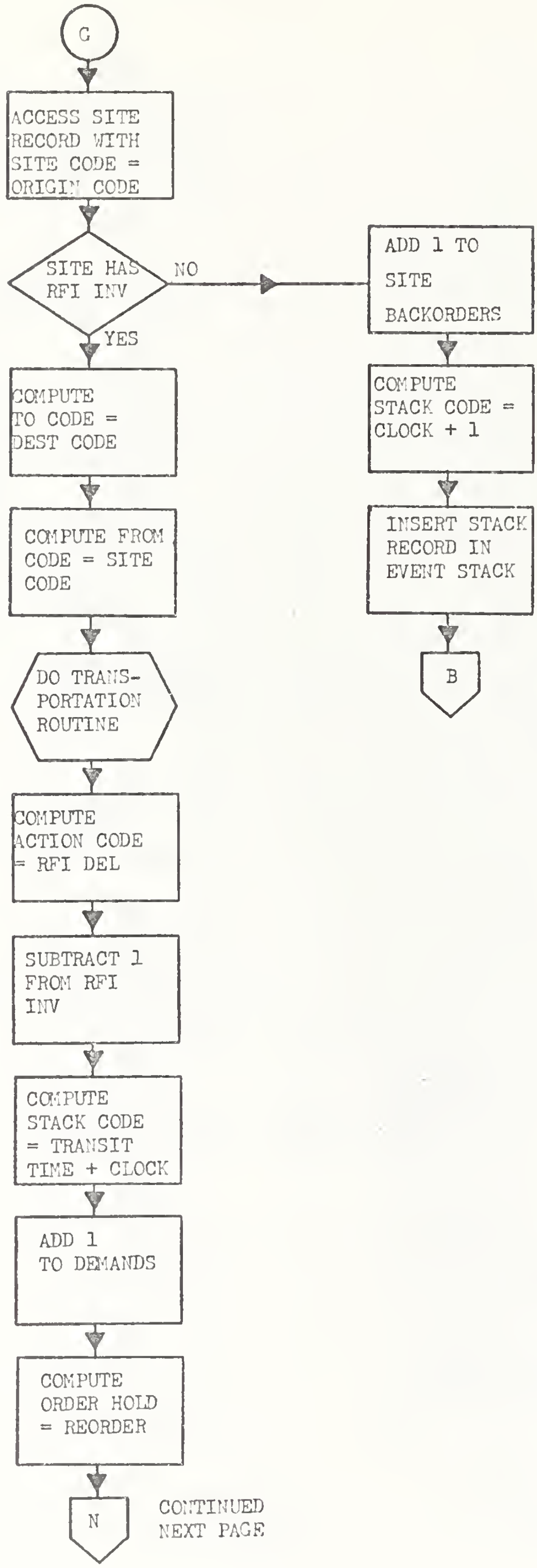
PROGRAMMED MAINTENANCE ACTION
ROUTINE

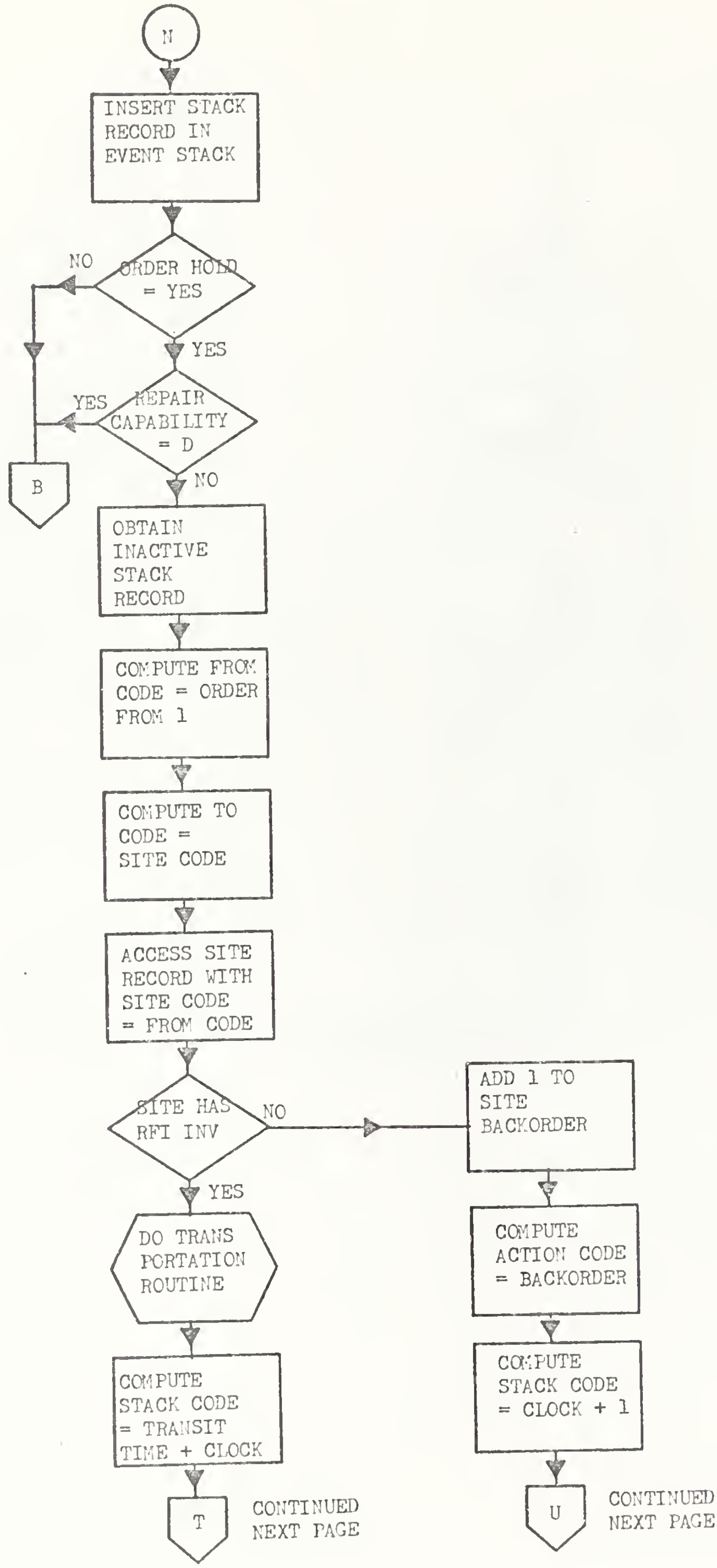




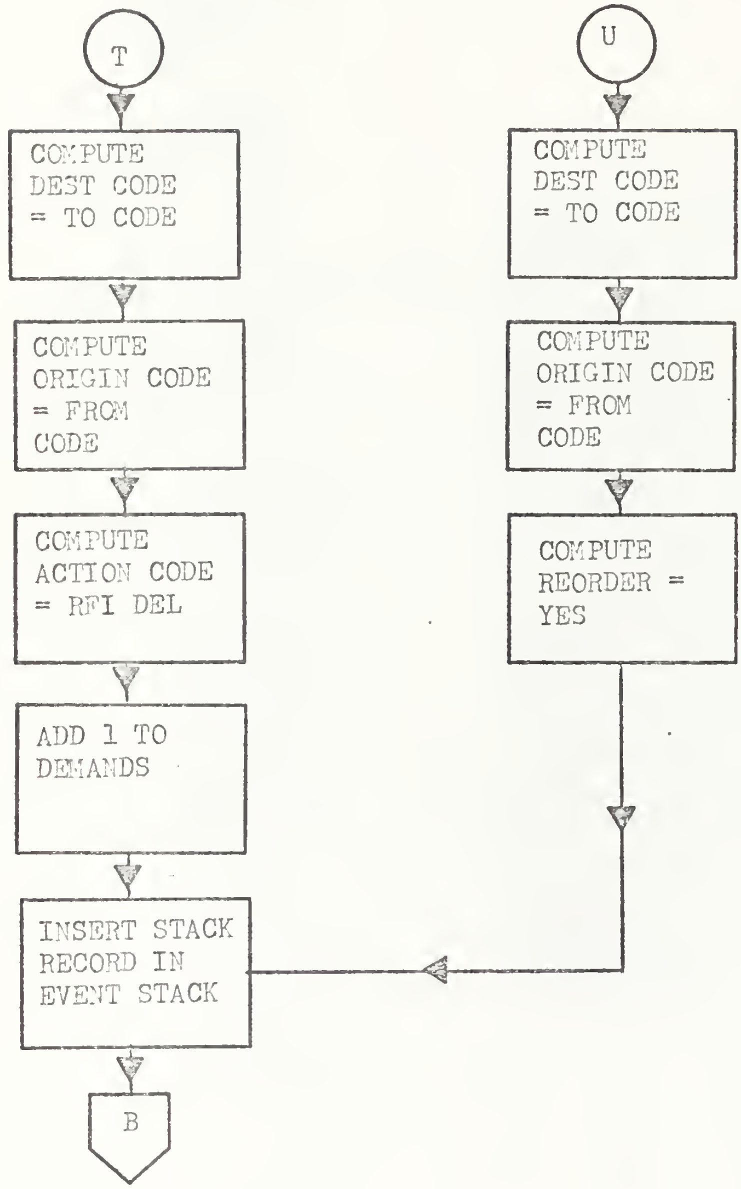
P
COMPUTE TO CODE = ORDER FROM 1
DO TRANS-PORTATION ROUTINE
COMPUTE DEST CODE = TO CODE
COMPUTE ORIGIN CODE = FROM CODE
COMPUTE STACK CODE = TRANSIT TIME + CLOCK
COMPUTE ACTION CODE = RFI DEL
INSERT STACK RECORD IN EVENT STACK
B
Q
COMPUTE DATE INSTALLED = CLOCK
INSERT STACK RECORD IN EVENT STACK
OBTAIN IN-ACTIVE STACK RECORD
COMPUTE TO CODE = ORDER FROM 1
COMPUTE FROM CODE = SITE CODE
DO TRANS-PORTATION ROUTINE
COMPUTE STACK CODE = TRANSIT TIME + CLOCK
COMPUTE REPAIR CODE = D
COMPUTE ACTION CODE = NRFI DEL
COMPUTE DEST CODE = TO CODE
COMPUTE ORIGIN CODE = FROM CODE
INSERT STACK RECORD IN EVENT STACK
B
S
COMPUTE STACK CODE = CLOCK +2
INSERT STACK RECORD IN EVENT STACK
OBTAIN IN-ACTIVE STACK RECORD
DO FAIL TIME SUB-ROUTINE
R
COMPUTE STACK CODE = FAIL TIME + CLOCK
COMPUTE DEST CODE = SHIP CODE
COMPUTE DATE INSTALLED = CLOCK
COMPUTE ACTION CODE = FAILURE
COMPUTE ITEM NUMBER = HOLD ITEM
INSERT STACK RECORD IN EVENT STACK
B

BACKORDER ROUTINE

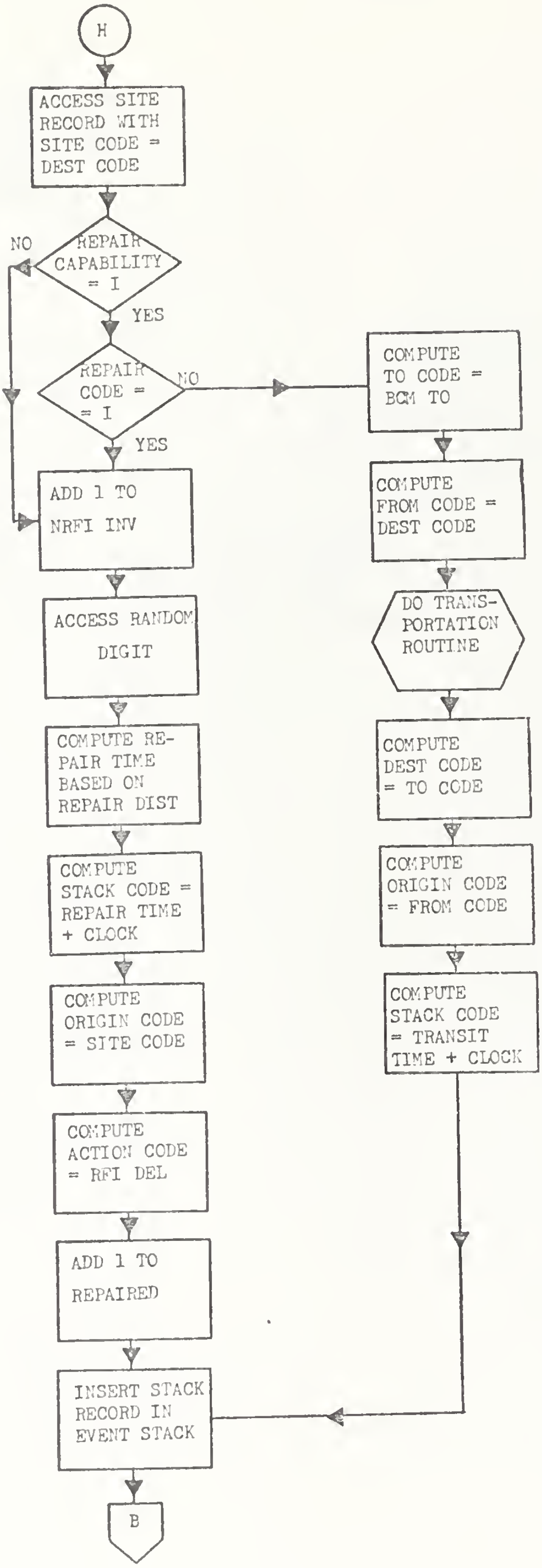




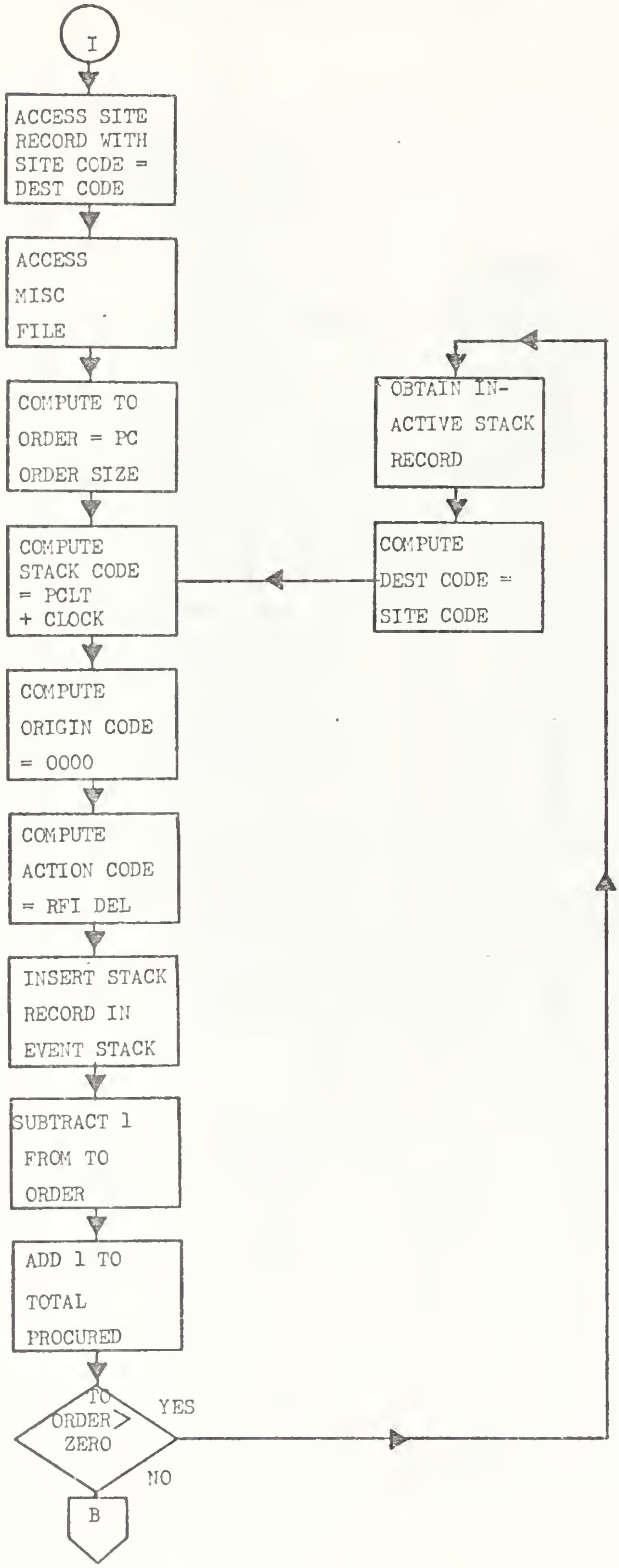
N
INSERT STACK RECORD IN EVENT STACK
ORDER HOLD = YES
NO
YES
REPAIR CAPABILITY = D
YES
NO
B
OBTAIN INACTIVE STACK RECORD
COMPUTE FROM CODE = ORDER FROM 1
COMPUTE TO CODE = SITE CODE
ACCESS SITE RECORD WITH SITE CODE = FROM CODE
SITE HAS RFI INV
NO
YES
ADD 1 TO SITE BACKORDER
COMPUTE ACTION CODE = BACKORDER
COMPUTE STACK CODE = CLOCK + 1
U
CONTINUED NEXT PAGE
DO TRANS PORTATION ROUTINE
COMPUTE STACK CODE = TRANSIT TIME + CLOCK
T
CONTINUED NEXT PAGE


T
COMPUTE DEST CODE = TO CODE
COMPUTE ORIGIN CODE = FROM CODE
COMPUTE ACTION CODE = RFI DEL
ADD 1 TO DEMANDS
INSERT STACK RECORD IN EVENT STACK
B
U
COMPUTE DEST CODE = TO CODE
COMPUTE ORIGIN CODE = FROM CODE
COMPUTE REORDER = YES

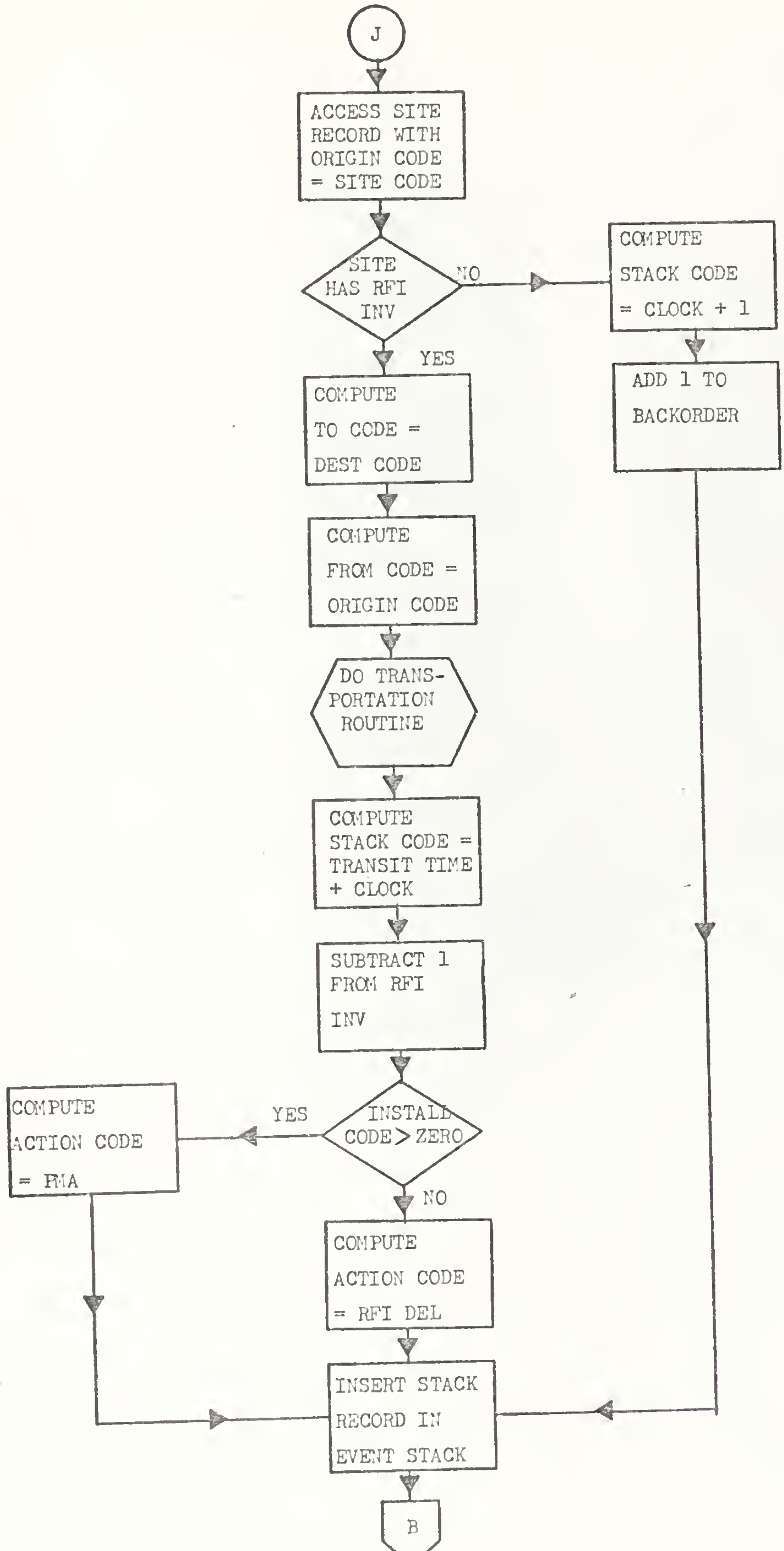
NRFI DELIVERY ROUTINE



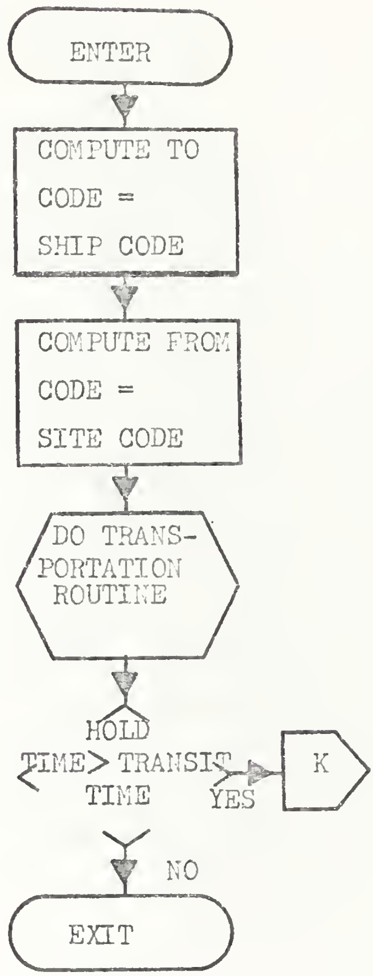
PROCUREMENT ROUTINE



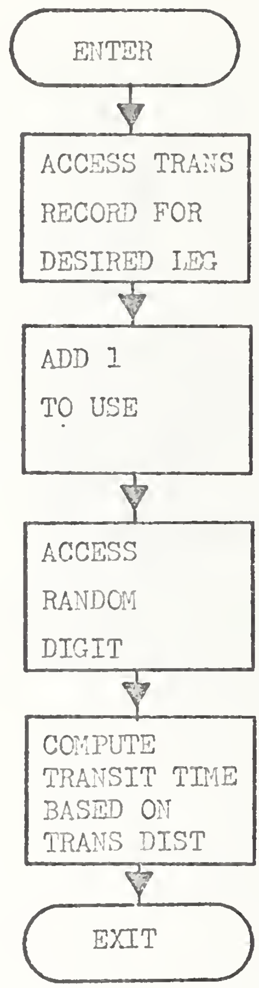
STOCK/PROGRAMMED MAINTENANCE ROUTINE



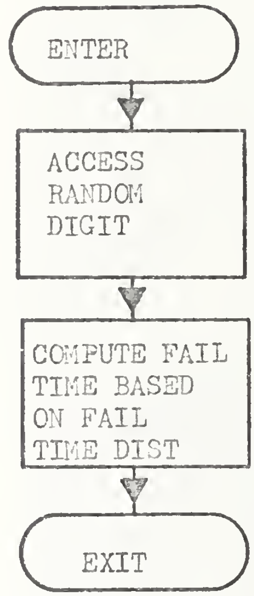
TIME COMPARE SUBROUTINE



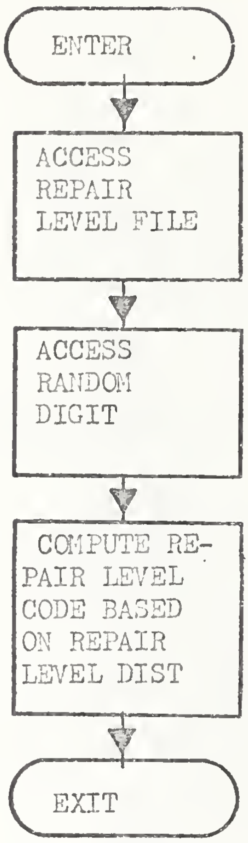
TRANSPORTATION SUBROUTINE



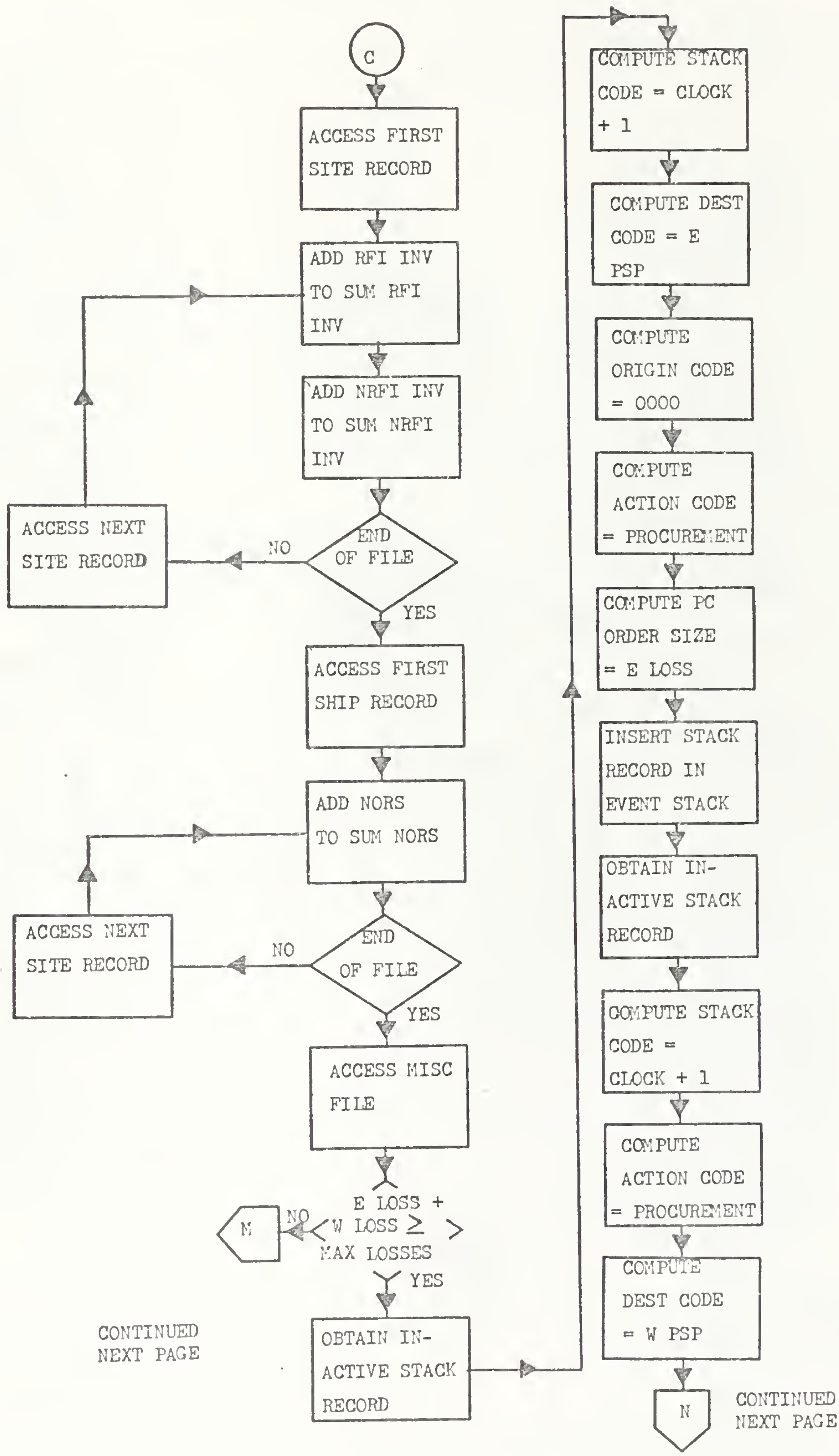
FAIL TIME SUBROUTINE

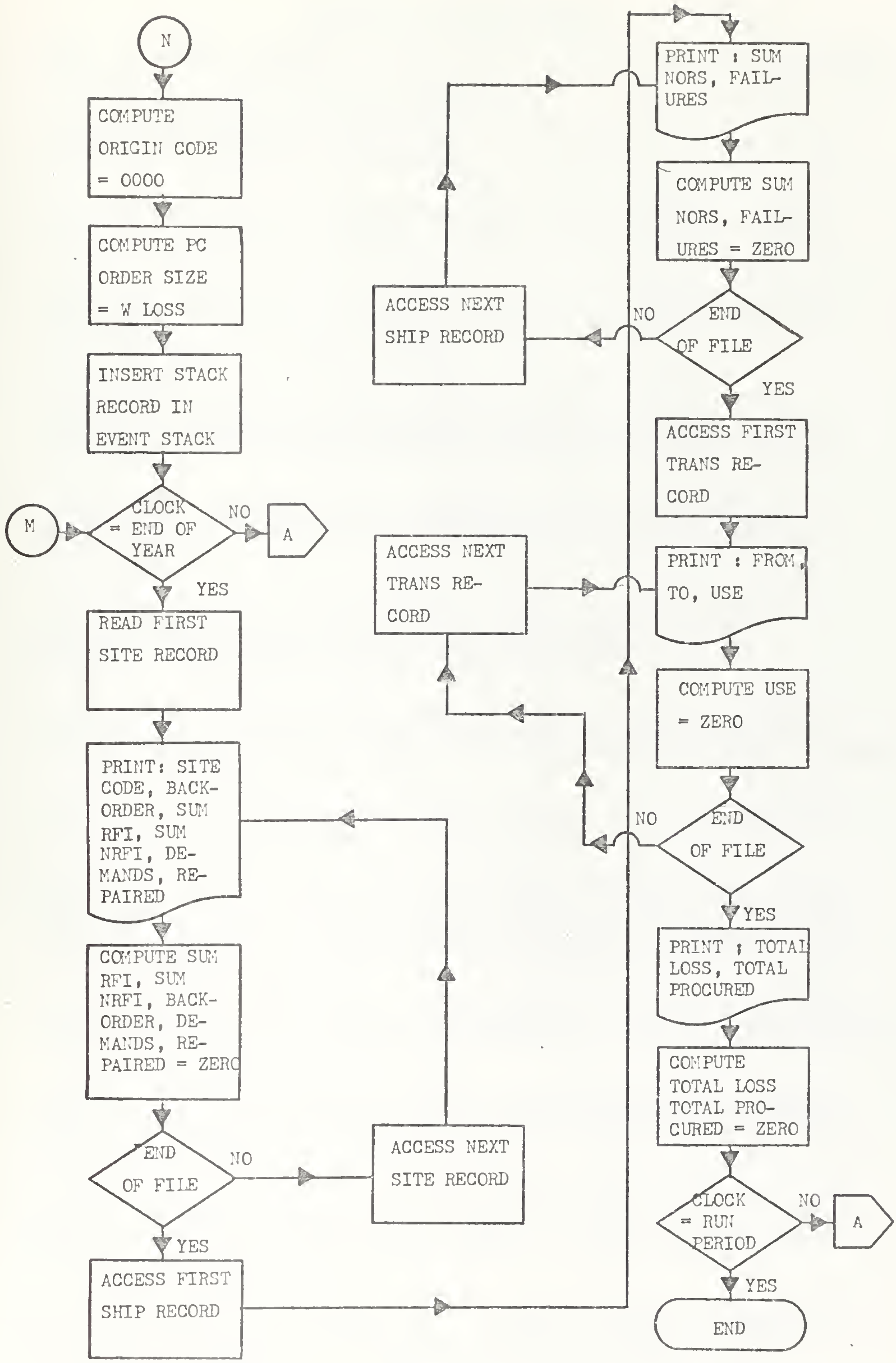


REPAIR LEVEL SUBROUTINE



CLOSEOUT/PRINT ROUTINE




N
COMPUTE ORIGIN CODE = 0000
COMPUTE PC ORDER SIZE = W LOSS
INSERT STACK RECORD IN EVENT STACK
M
CLOCK = END OF YEAR
NO
A
YES
READ FIRST SITE RECORD
PRINT: SITE CODE, BACK-ORDER, SUM RFI, SUM NRFI, DE-MANDS, RE-PAIRED
COMPUTE SUM RFI, SUM NRFI, BACK-ORDER, DE-MANDS, RE-PAIRED = ZERO
END OF FILE
NO
YES
ACCESS NEXT SITE RECORD
ACCESS FIRST SHIP RECORD
ACCESS NEXT SHIP RECORD
ACCESS NEXT TRANS RE-CORD
PRINT : SUM NORS, FAIL-URES
COMPUTE SUM NORS, FAIL-URES = ZERO
NO
END OF FILE
YES
ACCESS FIRST TRANS RE-CORD
PRINT : FROM, TO, USE
COMPUTE USE = ZERO
NO
END OF FILE
YES
PRINT : TOTAL LOSS, TOTAL PROCURED
COMPUTE TOTAL LOSS TOTAL PRO-CURED = ZERO
CLOCK = RUN PERIOD
NO
A
YES
END

LIST OF REFERENCES

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Thesis
C4774 Christopher
c.1 The proposed comprehensive distribution system for the LO-MIX rotatable pool assets.